GAO

Report to the Honorable
Vic Fazio, Chairman, Subcommittee on
Legislative, Committee on
Appropriations, House of
Representatives

SP-069

November 1990

SHARED RESOURCES PROJECT

Evaluation Report

GAO

United States
General Accounting Office
Washington, D.C. 20548

November 29, 1990

The Honorable Vic Fazio
Chairman, Subcommittee on Legislative
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

As requested in the report to the fiscal year 1991 Legislative Branch
Appropriations Bill, I am sending you our review of GAO's Shared
Resources Pilot Project, which is part of GAO's continuing commitment to
effectively use technology to improve our work. The pilot was intended
to develop and evaluate mission related applications using local and
wide area networks.

Our commitment to use technology to more effectively do our work,
which you and the Subcommittee have supported over the last several
years, has yielded significant improvements in our responsiveness to
Congress. Specifically, since 1985 GAO's annual work load has increased
from 1,032 assignments to 1,705 assignments, with the total number of
products released increasing from 852 to 1,446. At the same time, our
authorized staffing level has remained unchanged. These results would
not have been possible without computer technology. Such technology
has become indispensable in meeting our mission objectives. Today, vir-
tually all staff members within the agency use computers in doing their
work. We foresee the increasing workload trend continuing to outpace
our ability to obtain additional staff resources and are therefore contin-
ually looking for ways to meet the demands placed upon us by more
efficiently and effectively doing our work.

We believe that connecting staff and managers through networks is a
further enhancement which will help us meet increasing workload
demands. We have found, in this first year of pilot operation, that a net-
work allows easier access to information for all users. This result is par-
ticularly significant for GAO because of the geographically diverse body
of program evaluators, analysts, and technical specialists located
throughout the United States and in overseas offices. The nature of our
work requires this staff to be interactive in order to support the broad
range of topics required to meet congressional needs. Although GAO's
staff is currently connected by telephone, mail and courier service, and
personal visits, frequently such connections are not adequate—being
restricted by time, expense, or the need to transmit high volumes of
data. The pilot has clearly demonstrated the potential for using net-
works to overcome these limitations and improve both the timeliness
and quality of our work and ease the administrative burden on our

evaluator staff. Further, the pilot has demonstrated that managers and assignment supervisors can use the flexibility provided by the network to improve their project coordination and oversight. Finally, the pilot has provided initial insight into the possibilities of using networks to automate routine office functions and increase the efficiency of our administrative operations.

Accordingly, I have instructed GAO's Office of Information Management and Communications (OIMC) to use the information gained from the pilot project experience to develop specific requirements for a GAO-wide network. I expect to have those requirements and the procurement strategy available for review by our Information Resources Executive Board in August 1991, and have set a goal of 1993 for the complete installation GAO-wide.

Further, I have asked the Assistant Comptroller General for Operations to address other issues brought to our attention by the project team. These issues include 1) examining our work processes to determine if changes can improve productivity, 2) providing greater access to microcomputers by staff, and 3) examining the mix of computer hardware available for purchase and evaluating our need for more advanced personal computers.

In reporting to the Subcommittee on the project's status last December, I noted our commitment to improving GAO's use and management of information technology. Part of that commitment resided in the Shared Resources Pilot Project. Although we have successfully completed the pilot, we will keep the project team in place through fiscal year 1991 to allow project participants to continue their important role in developing GAO-wide network applications.

Another part of my commitment was to strengthen GAO's ability to effectively manage its information resources. In April 1990, I established an advisory structure to enlist the involvement of GAO's top management in developing an effective information resources management (IRM) program. The Information Resources Executive Board, comprised of senior GAO officials, provides overall direction and advice on the IRM program's vision, goals, policies, priorities, and strategic plans. The IRM Steering Committee, consisting of line and staff office managers, advises the Assistant Comptroller General for Operations on the operating plans and issues that must be addressed.

Additionally, in August 1990, I reorganized our IRM activities to enhance our ability to deliver services. The creation of that new organization, the Office of Information Management and Communications, should strengthen GAO's capabilities in planning, policy development, and customer relations. It also should provide the framework needed to manage all phases of our information resources program including the automated information that comes into GAO, moves among and within GAO units, and is eventually disseminated to our outside customers in the form of GAO products and services. I have directed that this new office give top priority to developing an effective planning process and ensuring that GAO technical resources are available to support our IRM program.

In closing, I would like to reemphasize my commitment to use technology to improve GAO's responsiveness to Congress. I strongly believe that GAO's ability to continue to meet our increasingly complex work load will depend on our ability to increase productivity through information technology. Our progress to date could not have been realized without your support and the support of the committee. I appreciate that support and look forward to working with you as we implement the next phase.

Sincerely yours,

Charles A. Bowsher
Comptroller General of
the United States

Contents

Appendix VII
Network User
Questionnaire

Figures

Abbreviations

GAO	General Accounting Office
OIMC	Office of Information Management and Communications
IRM	Information Resources Management
RCED	Resources, Community, and Economic Development Division
HRD	Human Resources Division
SFRO	San Francisco Regional Office
LAN	Local Area Network
PC	Personal Computer
DOS	Disk Operating System
IEEE	Institute of Electrical and Electronic Engineers
FY	Fiscal Year
CFR	Code of Federal Regulations

Shared Resources Project Evaluation Report

The Shared Resources Project is a cooperative effort among two GAO divisions—the Resources, Community, and Economic Development Division (RCED) and the Human Resources Division (HRD)—and the San Francisco Regional Office (SFRO) to test and evaluate audit-related ADP applications in a network environment; and further, to use this test to help specify the requirements for a GAO-wide network. Although the test was to be primarily focused on the way assignments are conducted through the development of electronic workpapers, automated indexing/referencing, and report review and processing; the network was extensively used for other aspects of assignment and unit management.

After one year in operation, the Shared Resources Project has been successful. It has shown that easier access to information and sharing of that information among a broad spectrum of users will improve both the timeliness and quality of our work and ease the administrative burden on GAO's evaluator staff. The Project also allowed us to more clearly identify the critical requirements necessary for successful implementation of a GAO-wide network.

With the assistance of GAO evaluation design experts, we developed a study methodology aimed at substantiating the benefits and limitations of using local area networks to improve GAO's operation. Our review included interviewing unit and assignment managers about their experiences in using the local area network (LAN), developing case studies on individual assignments being conducted to test LAN applications, preparing summaries of the results of our applications development, and assessing our network operations and management. This effort was supplemented by three independent consultant reviews of network operations and pilot applications. In addition, we surveyed all users in the three participating units through a questionnaire; over 500 staff shared their experiences and insights. An analysis of their comments on LAN usage, performance, and impact on job and management performance is incorporated in this report. A detailed analysis of the questionnaire responses is provided in appendix VI. Further details on our review methodology are included in appendix I.

Network Use and Benefits

Currently, over 1,000 users have access to the network. Almost 80 percent of the staff responding to the questionnaire use the LAN with a smaller percentage (23 percent) doing over one-half of their work on the LAN. Although the Project's initial objectives focused attention on a limited number of assignments, we found that the LAN was used throughout

the test units for three primary functions: assignment conduct, assignment management, and unit management. Each of these is briefly summarized below. Additional details on network use are provided in appendices II and III.

Assignment Conduct

The basic unit of GAO's work load is the individual assignment. We tested potential applications related to job performance on all or some portion of seven individual assignments. These assignments used electronic files to store and share information and electronic mail (E-mail) to facilitate job management, communication and, in some cases, to develop draft and final products.

Workpapers are the backbone of any GAO assignment. They comprise the textual, graphic, data, and physical documentation upon which we base our findings and recommendations in pursuing assignment objectives. Many of our workpapers are still prepared as handwritten and typed documents. However, in recent years, workpapers have increasingly been created and stored on stand-alone personal computers (PCs). They are typically transferred between job staff at different locations either physically on disk, or tape, or by using modems. Successful completion of any assignment depends on the orderly collection, review, and analysis of relevant material found within the workpapers. For complex assignments, this material may fill dozens of volumes and be located at various audit sites across the nation. As a result, workpaper access may be limited at any one point in time to only those staff at a particular location.

Project results in this area demonstrated that the network helps staff complete assignments more quickly and efficiently. For example, in one test assignment involving a headquarters group and three regional offices, one region was connected by the network to headquarters while the other two were not. The networked region transmitted electronic workpapers and other documents to the Washington supervisor for review on a continual basis. The other two regions' workpapers and products received periodic review when visited by headquarters staff. As a result, headquarters staff were able to interact more easily and meet assignment objectives more efficiently with the networked region than with the two regions that were not networked.

Another assignment used the network to prepare testimony under extremely tight time frames. Drafts were prepared and transmitted via the network from a remote site to headquarters where they were

reviewed and returned electronically with comments. Electronic sharing allowed simultaneous review by all involved parties. The issue area director stated that the normal drafting and review process involved multiple trips across town. Using the network saved considerable time and allowed him to better accomplish the review process.

Overall, we found that 80 percent of frequent (weekly and daily)[1] LAN users asserted that the network had a positive impact on the timeliness of their assignments, and over 69 percent believed that it improved job quality. Those who used the LAN less frequently generally felt that it had less impact. Generally, we found that the network offered opportunities to improve the quality and timeliness of data analysis by offering all staff on an assignment an opportunity to have quicker access to relevant data. These improvements resulted from

- simpler organization of assignment workpapers and files;
- easier and concurrent draft development by different groups using the same files; and
- greatly improved communications with remote staff regardless of location or time.

We also identified immediate and long-term potential benefits. Network use can

- facilitate analysis by allowing search and retrieval of data within large internal data bases; and
- provide direct access to agency data bases for input into job files.

Assignment Management

In the current GAO environment, assignment management is dependent on paper and communication. In planning and initiating an assignment, a number of administrative forms need to be prepared and forwarded through various levels of review. As an assignment proceeds, its status is tracked through additional administrative forms that provide information on staff-day usage, cost, and milestones. These forms must also go through a number of reviews throughout the organization. To update these forms with current information, evaluators-in-charge and assistant directors need to solicit information from the various staff on the assignment. This process becomes more tedious and cumbersome if

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[1]Frequent users represented only about 23 percent of all users. As described in later sections, use was curtailed for a number of reasons including lack of staff access to microcomputers, limited software availability, and limited reliability of network operating software.

assignment staff are located in a regional office or at a remote audit site. In these instances, making contact with staff while playing "phone tag" is very time-consuming and frustrating.

As a result of the Project, assignment managers, who typically direct one or more assignments simultaneously, found significant utility in the network. One manager who was in charge of six assignments relied almost completely on the network to monitor job progress, review work plans and interviews, and relay job-related decisions. This manager stated that her performance would be greatly diminished without the network.

We found that by using the network, managers are able to

- monitor assignment progress in a more timely manner;
- review pertinent job material from remote locations, without relying on personal visits; and
- keep their supervisors better informed.

We believe that managers will be able to use the network to

- process entire assignments from job planning through report issuance with little paper; and
- create data bases so that future assignments can make better use of existing material.

Using the network to improve information flow and access to staff and relevant job data will allow managers to make better, more accurate decisions regarding job direction and to better meet assignment milestones and audit quality standards. For example, assignment managers used the network to transmit quickly to division management the paperwork initiating an assignment, and in turn were able to receive approval much faster to begin the assignment. They also used the network to send in survey results and implementation-phase paperwork for quicker review and approval. Our questionnaire results also showed that over 74 percent of those staff using the LAN for assignment management on a daily/weekly basis believed that the LAN improved their quality of management, and over 96 percent asserted that it improved the timeliness of their management activities. This represents productivity gains at a time when workload demands are steadily increasing.

Unit Management

Unit managers typically fill such roles as Assistant Director, Issue Area Director, or Director for Operations/Planning and Reporting. They are responsible for directing large blocks of related work or for directing the activities of a work unit, region, or division. Unit management incurs constraints on a very broad scale. Although many of the divisions now have automated management information systems, they are still dependent on relevant information obtained from staff to prepare the various forms for input. In addition, many issue-area directors need to track staff and assignments at various remote audit sites, both locally and across the nation. Their ability to get timely and relevant information is dependent on how easily they can make contact with the appropriate staff. This process becomes particularly demanding if staff are located in different time zones.

The managers in the project units made fairly extensive use of the network, primarily in directing work at remote sites and for intraoffice communications. Over 89 percent of unit managers who use the LAN frequently said it improved the timeliness of unit management, and 76 percent said it improved the quality of unit management. For example, one manager estimated that 80 percent of his daily contact with his subunit managers is through the LAN. He stated that "the network is an essential tool for operations." In addition, the operations director for one division uses the network almost exclusively to keep in touch with her staff and relies heavily on the network for intradivisional communications. She finds that the staff, rather than feeling the network is an impersonal medium, believe they now have improved access to her, whereas before they may have felt intimidated or reluctant to make contact. This improves the staffs' productivity because they can resolve concerns and receive decisions quickly so that job progress can continue. As a result, the network has improved the overall effectiveness of her efforts and those of her staff.

We believe that additional opportunities for improved unit management can be obtained through increased network use that will result in better productivity, thereby allowing us to increase our workload. These include

- office automation, such as automated form development and processing, automated routing, and scheduling; and
- improved gathering and dissemination of information critical to assignment and unit management.

Network Limitations

During the course of the Project's first year, several limitations became apparent that limited our ability to develop applications and provide reliable network service. Some of these limitations were inherent in our network configuration and have been addressed. Others are related to GAO's communications infrastructure and the availability of personal computers, which, if not addressed, could hinder successful network development on a GAO-wide basis.

Workstation and Communications Access Are Not Sufficient

The most common observation made by users on our questionnaire was the absolute necessity to have on-demand access to computers. Without such access, network use was severely restricted. Further, users who are required to use modems to reach the network were handicapped by slow data transmission and the need to give up use of their phones in order to use the phone lines to connect to the network. While over 47 percent of "hard-wired" users make heavy use of the LAN (50 percent or more of their work was done on LAN), only 9 percent of the users connected by modem make heavy use of the LAN. About 31 percent of the questionnaire respondents who had to share a computer in a common work area never even use the LAN.

In addition, many of GAO's available computers are not adequate for network use. These older computers (using an 8088 processor chip) are being replaced by higher speed machines (using an 80286 processing chip), but even these may be limiting because software is increasingly being tailored to computers using the 80386 processing chip. For example, using Windows or similar multi-tasking software, which could enhance job productivity or facilitate office automation, requires a 386 type machine to perform acceptably.

Network Operations Were Not Reliable

The Project currently uses mini-computers as file servers. These particular computers were not reliable. System software contained numerous "bugs" which continually plagued the network and caused work sessions to be lost. Almost 61 percent of the staff felt that system reliability was a limiting factor in their use of the network. In addition, virtually every user or manager interviewed listed system reliability as a major problem.

As a result of these limitations, project participants went through a rigorous exercise to determine system requirements necessary to support their needs. With the assistance of several outside consultants we have thoroughly reviewed alternatives to the existing network configuration

and are prepared to proceed with proven network technology as we begin the first phase of implementation. In addition to meeting our reliability and operational requirements, it will be less expensive to purchase and operate than the existing system.

File Sharing and Transfer Is Difficult

In addition to reliability problems, the operating software would not allow for easy file sharing and transfer. This problem particularly hampered applications development efforts, such as automated workpapers, which were dependent on these functions for successful implementation. Further, dial-up users lacked the same filing and transfer capabilities available to hard-wired users. As a result, less than 20 percent of the staff regularly used the network for file sharing, and 28 percent of the staff used the network to transfer files. This problem will be corrected with the installation of our new network.

System Software Not Readily Available

Over 33 percent of system users reported inadequate access to software, a problem verified in our case studies. These users were unable to do critical analyses using data base or spreadsheet software as none was available for network use. Additionally, our case studies identified a lack of interoperability among network functions and software as a major concern. Switching from one software package to another was a lengthy process and frequently resulted in users staying in a stand-alone operation rather than moving to the network.

Technical Support Is Limited

Technical support for the system was primarily directed towards solving problems with the network configuration, thereby making support for other user problems limited. Extensive training was initially provided to all users and periodically offered during the Project. However, no on-line help was available, and formal training courses were not always available when needed. Almost 32 percent of LAN users believed that training was less than adequate, and 24 percent found that technical support was inadequate. Additional details on training are provided in appendix V.

Conclusions and Requirements

Networks are an essential tool for improving the way we work within GAO. Increased use of networks will lessen the effects of time and distance on communications among staff. Better communications offer an opportunity to improve both the timeliness and quality of our products. While system limitations did constrain network performance, we learned

from our experiences. A measure of the Project's success is that a mechanism was in place to record the limitations and to make timely adjustments where appropriate.

Our experience with the Project points out the critical requirements that must be met to assure that the benefits which can clearly accrue from network use be made available across GAO. These requirements provide a basic functional framework which, in conjunction with our consultant studies and our experiences with other network operations within the office, will provide a good basis for developing specifications for the GAO-wide network.

Network Configuration

Our experience with this network provides a good starting point for developing functional specifications for a GAO-wide network. GAO's organizational structure makes multiple, decentralized networks virtually mandatory. Our initial experience with a centralized server demonstrated that a centralized configuration lacks flexibility and cannot meet the different needs of GAO's various units. However, it also pointed out that these networks must be interactive so that any one person in GAO can communicate with any other person regardless of location. As such, these networks require a common architecture, compatible operating software, a common E-mail package, and similar procedures and standards for other operations. Appendix IV provides further details on network configuration.

Other operating parameters must also be considered in developing a requirements statement:

Communications: High-speed communications between and within networks is essential. Low-speed modems are largely unacceptable as communication links between users and the system. Staff should perceive no loss of response time in using the network (when compared to a stand alone mode-approximately 9,600 baud). Data transmission should be fast enough to facilitate file transfer of large data files.

Workstations: Workstations using the 80286 processor chip meet minimal current standards. However, workstations using the 80386 processor allow much faster processing speeds and the ability to take advantage of available software, such as multitasking. Strong consideration should be given to the 386 type workstation for future procurements.

Network Management

Although network configuration establishes the physical parameters of the environment, this environment requires significant management attention to function properly. In turn, network management requires skills and knowledge not widely available in GAO. Network management also calls for a close organizational linkage between the various units and the Office of Information Management and Communications (OIMC).

Further, as stated earlier, common standards among various GAO LANS are essential to enable communications links among all units. Even with common architecture, networks can be limited in their ability to "talk" to one another without identical or closely related operating rules and procedures. GAO's newly inaugurated Network Standards Committee is a step towards standardization. OIMC must ensure, however, that standards are developed and enforced.

Each LAN also needs a systems administrator to ensure that accounts are established, data back-up is performed, etc. While management of smaller LANS can be a part-time assignment, larger LANS will likely require full time attention and specialized training. Further, GAO requires an officewide network manager and sufficient staff to monitor, consult, and oversee all network operations. GAO is currently seeking such capability. Even though an agencywide LAN operator will require some additional management and administrative attention, GAO is convinced that the overall benefits to the line evaluator will more than compensate.

Finally, network security must be designed and built in from the initial phases of network design. Networks are vulnerable to computer viruses and unauthorized users. Good management practice and diligence can prevent most problems.

User Access

A well-functioning network is worthless if users are denied access to the system. The keys to access are workstations, software, and training, without which network use is severely restricted.

Workstations: An absolute criterion for network use is the unrestricted access of staff to workstations. Our questionnaire results, interviews, and case studies all indicate workstation access as the single most critical factor in determining network usage. Closely linked is the way that access is granted. Staff usage among modem users is significantly lower than that of staff directly connected to the LAN. This factor is directly related to our findings under network configuration that establish a

requirement for a system of networks. Rather than having many users connected to a central server by phone lines, many small networks would be connected by high-speed communications links.

Software and applications: Even with a well-equipped network giving access to all users, network use will remain limited without adequate software being provided. Network software must be as available and as easy to use as the software provided for stand-alone workstations. Providing interoperability among network functions (e.g. filing, data transmission, E-mail) and assignment software (e.g. word processing, spreadsheet analysis, and data base analysis) is essential. Participants in our test assignments cited a lack of interoperability as a major limitation in the existing network system. Again, referring to an earlier point, software considerations frequently drive hardware needs. Interoperability and concurrent applications require consideration of 386-based workstations.

Training: Training provides much of the glue that holds the network's ingredients together. As with network security, training must be a factor from the very beginning. Ease of training should be a major factor in selecting key network operating packages. The Training Institute has been part of the Project team throughout this first year. This involvement must continue in order to allow the Institute sufficient lead time to develop a training approach.

Finally, one overriding consideration requires attention. Our effort has been directed at using networks and associated technology to improve overall effectiveness and efficiency impacting on job quality and job timeliness. We believe, however, that concurrent with this effort systemic studies and tests should be conducted on how we work, how we review and process reports, and how we assure that customer needs are being met. Much of our current work is grounded in time-honored processes. Technology can facilitate this work and provide a vehicle for changing it. In addition, other factors must also be considered in improving the process, such as increasing the level of accountability, responsibility, and flexibility of work groups in developing products. Such considerations should not be driven by the Shared Resources Project. What the Project can do is provide a mechanism for testing different approaches.

Objectives, Scope and Methodology

The objective of this evaluation was to assess the progress being made to automate GAO mission-related applications, using local and wide area networks. The assessment served as a means for identifying and determining the functional requirements needed for a fully integrated GAO network. It also helped us identify the specific automated tools needed to develop, implement, and maintain reliable application programs that can be used on a GAO-wide basis. Participating units in the pilot effort included two headquarters divisions—the Resources, Community, and Economic Development Division and the Human Resources Division—and the San Francisco Regional Office.

To achieve our objective, we evaluated applications dealing with electronic workpapers, referencing and indexing, and report review and processing in terms of their ability and potential for facilitating the way we do our work. We also assessed whether these applications were technically feasible or efficient under the current operating network configuration. In doing so we identified benefits, both realized and potential, of a networked system, concerns and limitations incurred by users of the network, and the functional requirements needed for a fully integrated GAO network.

With advice from GAO's evaluation design experts, we pursued several means of gathering information to support our objectives. We interviewed 30 GAO officials, all having access to the network, to solicit their comments and suggestions on what the functional requirements of a GAO network should be. These included directors for operations and for planning and reporting, issue-area directors, assistant directors, evaluators, and technical support staff in the participating units.

We also sent a questionnaire to over 900 staff in the three participating units to obtain information on their use of ADP and the pilot network. From this questionnaire, we received 535 responses to such issues as how the staff used the network and the impact it had on their productivity and timeliness. In addition, we requested supporting documentation on the operations of the network and on the technical support required. These included

- individual summaries on the results of the three applications being tested in the divisions and the regional office;
- case studies of seven different assignments showing how the pilot network increased job quality, timeliness and productivity;
- a technical summary and functional requirements paper outlining the functional requirements that the network would have to support; and

- a summary highlighting the training requirements that will be needed to implement and sustain the network.

We found during the first year of pilot operations that system reliability and software operating problems hampered application development efforts such as automated workpapers. Although these problems have been resolved, the situation did limit our ability to measure the effects the network had on assignments selected for the pilot. While continued applications development will yield further evidence of actual benefit on a case by case basis, we believe that several factors preclude development of an overall cost/benefit analysis at this time. For example, because there is no "standard" GAO assignment, a valid analysis would require comparison of a large number of jobs over a long time frame with and without local area network capabilities. We believe, nevertheless, that the value and broad parameters of a network architecture have been successfully demonstrated.

Assignment Conduct

GAO is entering a new environment through its use of automated tools to facilitate its audit and evaluation work. Although we currently use commercial software to perform spreadsheet, data base, and statistical analyses, we have not adapted this software to assist in structuring our documentation or in report development, preparation, and review. As part of the Shared Resources Project, we have started to develop applications relating to three major components of assignment conduct—automated workpapers, report referencing and indexing, and report review and processing. These applications are being developed within the context of on-going assignments in GAO's Human Resources Division, the Resources, Community, and Economic Development Division, and the San Francisco Regional Office.

Our objective in developing these applications was to determine whether using the network to prepare workpapers and draft reports, and process these reports through an intensive review process, would enhance the timeliness and productivity of our work as well as the quality of our products. Specifically, we wanted to identify the advantages and disadvantages of using the network and the network applications to perform these tasks. This knowledge would, in turn, enable us to identify the functional requirements needed for a GAO-wide integrated network system.

We were able to recognize benefits in each application and identify a number of potential benefits that a networked environment will have on the productivity of our staff and the quality of our products. Unfortunately, our initial work on these applications was subject to a certain amount of trial and error as we began to adapt our work processes to a network environment. Problems with the network's hardware and software prevented us from accomplishing all of our objectives. Nonetheless, both our success and our failure helped us to identify critical requirements which must be met to assure that benefits, which can clearly accrue from network use, be made available across GAO.

While the following discussion details the specific benefits and limitations of the three assignment applications, one important consideration had an overriding impact on how much we were able to achieve under the Shared Resources Project: the full benefits of automation cannot be realized until a workstation is provided for every staff member. The purpose of automation is defeated if a staff member cannot get immediate access to information available on the network, and to do so the staff must have ready, on-demand access to a computer. Since many staff in GAO are not presently afforded this access, it was and continues

to be an overriding limitation in developing the assignment applications under the Shared Resources Project.

Automated Workpapers

Workpapers are the backbone of any GAO assignment. They comprise the textual, graphic, data, and physical documentation upon which we base our findings and recommendations in pursuing assignment objectives. Successful completion of any assignment depends on the orderly collection, review, and analysis of relevant material found within the workpapers. For complex assignments, this material may fill dozens of volumes and be located at various audit sites across the nation. As a result, workpaper access may be limited at any one point in time to only those staff at a particular location.

Historical Perspective

Many of our workpapers are still prepared as handwritten and typed documents. However, in recent years, workpapers have increasingly been created and stored on stand-alone personal computers (PCs). They are typically transferred between job staff at different locations either physically on disk, or tape, or by using modems.

The process of storing and transferring electronic data without a network environment is laborious, unstandardized, and nonsecure. Using Crosstalk and modems to transfer files between distant, stand-alone PCs is a time-consuming process requiring two computers, two staff, and four phone lines—two for the modems and two for the users to verbally nurse the file transfer process along. While this is a time-consuming and often frustrating task, it is still more efficient than sending files and data physically by public transportation.

Job file security is problematic with data often kept on multiple floppy disks—one set for headquarters staff and one for each region or supporting office. Not only does this process create the potential for losing track of the standard or "correct" version of a file held by multiple users, but floppy disks themselves are prone to damage, erasure, and theft. Secure, standardized file backup procedures that allow quick recovery of lost information are also rare in the current GAO stand-alone computer environment.

In addition, sharing data is not easy within our current environment. Access to data is generally constrained to staff at one particular location. When management or other staff at another location need access,

the data must be physically transported between the two locations. This procedure reduces productivity and is very time-consuming.

Finally, since most of our computer work ends up accumulating in numerous floppy disks stored in people's file cabinets rather than in a central data base, there is no easily reusable source of information from prior audit work. Too frequently in an issue area, or a line-of-effort within an issue area, the text, data, and graphics information from prior related assignments is hard to retrieve or, worse, lost because of staff rotation, retirement, or transfer of key individuals.

Activities to Date

During the past year, all three participating units in the Shared Resources Project used the network to create and share electronic workpapers. Electronic "folders" were created for all normal workpaper bundles, administrative documents were filed in the administrative folder, correspondence in the correspondence folder and so on, ending in drafts in the draft folder. Keywords were assigned to electronic workpapers as they were created to facilitate locating and working with all workpapers related to a given topic. None of the electronic workpaper assignments used in the Shared Resources Project progressed to the product-drafting stage, but efforts were taken to identify and test various text retrieval and assembly software that will facilitate that stage of our work.

We also successfully tested and used the wide-scale file transfer capabilities of the headquarters Data General minicomputer to speed the sharing of various job files between headquarters, site, and regional users. Unfortunately, because of problems with the network's hardware and software, we were not able to achieve all we had set out to do. However, we were able to identify and test appropriate software and hardware necessary to give an assignment's staff the ability to jointly assemble, analyze, and draft reports from centralized, shareable workpaper files.

In addition, we reviewed the literature and attended many contractor demonstrations of text scanner and retrieval systems, built prototype issue area and assignment databases, and successfully operated the prototypes in several graphical user interface environments.

Requirements

For automated workpapers to be successful, we need the ability to share with other responsible job staff any and all workpapers created. This

sharing must be provided quickly and must satisfy numerous inquiries simultaneously. In addition, staff should be able to search for pertinent information using a keyword or topic retrieval command that would access various workpapers on either one particular assignment or a number of assignments in a specific issue area. Staff also need the ability to scan agency-generated documents in order to retrieve pertinent data for job files. The more substantive and relevant the information in the workpapers, and the more available it is to various staff, the better our productivity on an assignment will be.

On the basis of the lessons we have learned in the Shared Resources Project over the last year, we identified the following generic requirements for an effective network-based automated workpapers system:

- Network access—all staff must be given access to the network, preferably with an individual workstation at each location. In addition, remote users must have the same capabilities as their counterparts in headquarters.
- Operational reliability—the network must be reliably available 24 hours a day, seven days a week with scheduled off-hour maintenance downtime. This availability must extend to all local area network (or cabled) users as well as all remote (or dial-in) users.
- Information security—the network must provide the highest level of password-based system access controls to prevent the unauthorized access, editing, or destruction of information stored in the system. Network administration staff within each division, region, or office in GAO should have absolute control over access by all their respective users to each organization's files and programs.
- Compatibility with existing software—the network must run all the word processing, spreadsheet, graphics, and data analysis software currently used in GAO with the same commands and ease of use as exists in the stand-alone environment.
- Ease of training and use—the network's compatibility with the installed base of GAO applications means that there should be no significant additional instruction necessary to train users in all network-based applications. New office automation applications such as electronic mail, calendaring, scheduling, file storage, retrieval, and transfer should be intuitively easy to learn and use by those GAO staff who have a wide range of computer skills.
- Speed—the network must run all word processing, data analysis, spreadsheet, graphics, and office automation applications with the same or greater speed as exists in the stand-alone environment. The network's processing, communications, and file-storage capabilities should be sized

so that full use of the network's applications by all members of the organization will not significantly degrade the speed of those applications.

- Easy exchange of information between various applications—the network should allow for easy "cut-and-paste" exchange of text, data, and graphics between its various applications. The ability to insert a graph or spreadsheet table into a word processing file will allow users to more easily integrate these various forms of evidence and analysis into an integrated, whole presentation.
- Ease of installation and maintenance—the network should be relatively easy to install and maintain by division, region, or office network administration staff. The network's operating system must be sufficiently developed, tested, and "debugged," and the documentation and procedures for system operations and maintenance should be fully developed. GAO's system staff should only have to learn and apply tested and reliable methods and procedures to keep the system running at full performance.

For additional details on the functional specifications required see appendix IV.

In addition to the generic requirements stated above, we also identified specific needs of a fully networked automated workpaper environment:

- A text retrieval system that works across multiple file types, allowing job staff to use "keyword" or "topic-based" searches to retrieve relevant information from text, data, and graphic files residing in the assignment data base. Using the assignment plan as the foundation around which the assignment message is assembled, the various facts pertaining to the diverse elements of a finding can be assembled into summary workpapers, analyses, and report drafts. These can then be made immediately available for review and editing by local and distant staff and managers.
- A multiple subdirectory structure, similar to that which is allowed under a DOS-like network operating system, which would allow the Information Manager and other job staff to easily build and modify file structures that correspond to the way the assignment's information is being assembled.
- An electronic notepad capability, which permits supervisory and referencer comments to be "clipped" to the document and responses to be "clipped" right beside them electronically. Using a keyword and topic

search capability and an electronic clipboard, a complete electronic evidentiary record would be maintained and be electronically retrievable at any time up to and after a product is issued.

Benefits of Automating This Process

Automated workpapers, using electronic files stored on network-accessed file servers, would offer all certified users on-demand access to the critical assignment documentation, summaries, and analyses necessary to prepare workpapers, draft reports, and process these reports through various levels of review. Automation would allow multiple headquarters, site, and regional users from various physical locations to gain read- and write-controlled access to common workpapers centrally stored under the control of an information manager on an assignment. To ensure security and safekeeping, these files would be automatically backed up by the network administration staff. Automated workpapers would also provide for a quicker review of workpapers and draft reports, thereby facilitating analysis and comment.

We believe that by allowing all relevant assignment staff and managers to have continual and better access to the growing evidentiary base earlier in the assignment process, assignment timeliness and quality can be improved. This access would improve the collective knowledge of what has been learned on the assignment, thereby offering some assurance that the job direction and report message are based on all pertinent information collected. Assignment and issue area managers, in regional offices, audit sites, and headquarters would have simultaneous, shared access to evidence gathered in accordance with the approved methodology and work plan, and would be able to make better joint decisions on how to best meet the milestones of the assignment and meet the audit quality standards of the office.

Indexing and Referencing

Indexing our workpapers is one of the most critical functions in the performance of our audit work. Workpaper indexes allow quick and complete access to the information contained in the documents we gather and the analysis we perform. Because workpapers are quite voluminous, access to data in them would be impossible without a good indexing system.

Referencing is a significant quality control mechanism. Because the subject of our reports are often complex and based on information obtained from a number of different sources, it is possible to make mistakes. Without independent review and verification of the report statements,

these mistakes might not be identified before issuance of the report and could result in serious consequences. GAO's reputation for accuracy would suffer and, as a result, our ability to promote improvements in government could be compromised.

Historical Perspective

Indexing has historically been a tedious manual process. At the start of an audit the evaluator-in-charge of an assignment devises an indexing system. The system generally uses a series of codes that help classify the documents created or gathered during the course of an audit. These characteristics include

- the GAO unit performing the work;
- the agency where the work is performed;
- the type of workpaper (interview, analysis, agency document); and
- the assignment objective addressed by the workpaper.

The referencing process has historically also been a manual process that is time-consuming and, like indexing, quite tedious. The referencing process begins with the report author noting workpaper indexes for each line of the report. A staff member who has not participated in the assignment is then selected as the referencer, and is responsible for reviewing each cited workpaper and determining if it supports the statement in the report. If the referencer decides that the support is not adequate, the report author must either add new support, clarify the support already provided, or change the report to accurately reflect what is in the workpapers.

The indexing and referencing procedures have served us well over the years but they have some drawbacks. First, we often have a number of issues on an assignment, which necessitates extensive, time-consuming indexing and cross-indexing between various workpapers. Second, it is very time-consuming to review multiple workpapers that are cross-indexed in support of a point. Third, because of the tedious nature of the indexing and cross-indexing process, it is sometimes not done in a thorough manner. Finally, referencing is extremely tedious work, and although staff are always thorough in performing the function because of its critical importance to GAO's report quality, it is inordinately time-consuming and frustrating.

Activities to Date

Over the last year, staff in the San Francisco Regional Office, the unit responsible for developing this application, automated all the

workpapers on a review of indirect medical education. The workpapers were stored on-line and were indexed using the Data General Comprehensive Electronic Office filing and keyword software. Documents gathered from the agency being audited were not scanned and stored electronically but an index of them was created and stored on the Data General.

To develop the referencing portion of the application, the SFRO staff performed a referencing test on a segment of a workpaper summary. The results were encouraging in that it showed that accessing electronically stored workpapers was much quicker than accessing hand written or typed workpapers. The only difficulty experienced with using electronically stored workpapers was moving back and forth between workpapers if two or more sources were given in support of a statement in a report. Nonetheless, the test demonstrated the feasibility and practicality of storing, indexing, and retrieving workpapers electronically.

Requirements

The requirements for indexing and referencing are simple. We must be able to quickly find all pertinent and relevant workpapers that address assignment issues and topics. Evaluators, when preparing to write a report or summarize their work, need to be able to review all workpapers that relate to their topic so it can be thoroughly addressed. Referencers need to have the same access to the workpapers so that they can ensure that what is written is supported by the workpapers.

Specific requirements we identified for indexing and referencing include

- the option to predefine a set of keywords for search purposes,
- a directory of keywords that can be searched and used to automatically index workpapers,
- the ability to search workpapers quickly to identify index linkages not preset as keywords,
- the ability to access all keyword-linked workpapers at the same time for purposes of reviewing multiple references,
- the ability to do hypertext searches through assignment workpaper data bases, and
- the ability to quickly change keyword linkages if there is a change in the direction or objectives of an assignment.

Benefits of Automating This Process

GAO can achieve tremendous benefits through automation in the areas of referencing and indexing. We could achieve more thorough indexing and cross-indexing and have faster access to the workpapers for both the audit team and the referencer. This capability would both improve the quality of our products and reduce the frustration felt by the staff in performing these functions.

Using the process, the referencer would have instant access, via a computer terminal, to all workpapers supporting a report. The specific sections of the supporting document would be highlighted and related to the section of the report it supports. The referencer's decision whether to accept the document as proper support or to identify a need for additional support would be entered electronically, and the staff would respond electronically. Overall, the process would be made more efficient and timely, and product quality would be improved since all relevant workpapers supporting the report could be easily accessed.

Report Review and Processing

The report review process is a significant and critical component of our assignment conduct. During this time our products receive detailed scrutiny to ensure they are of high quality and in accordance with GAO policies. This process covers the period during which a draft product undergoes various levels, and often multiple iterations, of divisional and nondivisional review by staff outside of the assignment. Reviewers include division and region management, report review staff, writer-editors, attorneys, and others who examine the product for appropriateness of overall message, adequacy of supporting evidence, grammatical correctness and other quality standards.

Historical Perspective

Traditionally, the report review process has been satisfied through a detailed review of the product, commenting by reviewers, and consolidation of comments by assignment staff, processing of administrative forms, and tracking of product status through telephone calls or personal visits. These manual processes are time-consuming and have placed a significant burden on evaluators who must shepherd a product through to completion.

The specific steps included in the report review process include first stage edit, preliminary review, obtaining agency comments, final review and coordination with other GAO units, and final processing. During each stage the product is usually reviewed by more than one person, usually sequentially, and requires several iterations to ensure all comments are

addressed. The assignment team is responsible for collating, responding to, and incorporating comments made by the various reviewers.

Activities to Date

During the past year, we used various means to identify and, where practical, acquire software to test for applicability to report review and processing. For example, early in fiscal year 1990, GAO issued a Request for Information for "groupware" applications, which allowed us to obtain software for evaluation and test purposes. Groupware is software that helps groups of workers, mostly professionals, control their workflow and manage their work content.

We also reviewed an Office of Policy report on assignment automation that included a review of group productivity software. This included information on (1) group/team writing, (2) group memory management, (3) group conferencing, (4) group scheduling and tracking, and (5) E-mail (which we are currently pursuing).

In addition, we reviewed numerous professional and technical publications for applications that have potential for meeting our system needs, and we identified several potential applications to test for usefulness to our work processes.

We have developed procedures and a data collection instrument for evaluation of the various products identified and any additional products we select for implementation and evaluation. The data collection instrument will allow us to collect from the users the necessary information for consistent and thorough evaluation of all software application products.

Requirements

The report review and processing phase of our work needs to be done quickly and efficiently. The Congress should not be expected to wait weeks or months after our data gathering efforts are concluded to receive our reports. Managers who are responsible for product review need quick, simultaneous access to drafted reports if they are to expedite this process. They need the ability to search for supporting data, if necessary, to check on a statement's relevance and propriety. Their comments, in turn, need to be quickly transferred back to the job staff for action. In addition, a more efficient mechanism for handling the administrative forms, which track a report through final processing, is needed to alleviate the time-consuming manual tasks now in place.

On the basis of our experience in fiscal year 1990, we identified several basic requirements that must be satisfied by any system we develop or implement in GAO:

- Users at any level of technical competence should be able to access the system and move between functions with great ease and minimum formal training. For example, a user should not be required to perform a long series of keystrokes or steps to move from WordPerfect to electronic mail, and back. Also, the method of access to the system and its capabilities should be the same, regardless of the user's location. (We often refer to this as "full membership" on the network.)
- The system must be flexible enough to accommodate those instances where methods or processes cannot be standardized. Within GAO, the report review process, and assignment conduct in general, varies between organizational units. Also, the nature of assignments, deadlines, management styles, and other factors have considerable effect on how the report review process is handled.
- Electronic transfer of documents through electronic mail could dramatically improve the flow of products through the report review phase. The benefits of these features are most significant where staff who are not collocated must communicate and share information, such as at audit sites and regional offices. One specific example involves communications between GAO headquarters and the San Francisco Regional Office. The time difference makes communication between these sites inconvenient at best. Using electronic system features, a staff member in San Francisco can mail a document for review along with a message to a headquarters staff member late in the business day. The message or file will be immediately available to the headquarters staff member early the following morning, and well before the start of the business day in San Francisco.

We also were able to identify more specific requirements that relate directly to report review and processing:

- Any system acquired by GAO should support writing tools and other related software for use by evaluators. Software for spell checking, grammar checking, document comparison, and co-authoring can assist evaluators in producing higher quality drafts. Many of these packages can be customized to check documents for specific GAO format and style. Subsequently, reports submitted for report review would require fewer modifications.

- It is imperative that the system allow comparison of several documents and access to supporting data during the review process. This requirement can be accomplished through a split screen or windows environment, where more than one document can be simultaneously displayed on a computer screen. Although we have identified this feature as a requirement for report review, it would be useful throughout the assignment process. For example, much of the work in preparing a report involves extracting and merging data and text from multiple source documents. We need the ability to easily extract and merge data from multiple files into a final product. Moreover, when referencing products, staff members examine evidence that is often in multiple formats. Simultaneous display of documents would allow them to accomplish this task with greater ease.
- Many stages of report review are or can be satisfied through concurrent review of a product by multiple reviewers. An easy-to-use electronic mail system can support this process by allowing quick and easy movement of a document through the various review stages. Shared filing can provide reviewers with access to supporting documentation in addition to the product under review. Together, these features can provide assignment staff with a means of collecting and maintaining an audit trail of reviewer comments.
- Document-comparison software could also provide a quick way for assignment staff to identify differences between two documents. It would display or print summaries of document differences, which could be beneficial when collecting and processing reviewer comments.
- Staff should have access to real-time information on the progress of products in review. Once a product has been submitted for report review, assignment staff and others must track its status through telephone calls and personal visits. Tracking is time-consuming and can be costly if it involves local travel. To improve this process, a system to track, document, and provide information on the status of a product as it is processed through the review cycle is needed. This system would also provide valuable information on time frames, which would help to analyze and streamline the report review process.
- Automated review and commenting software would allow easy consolidation of all comments from reviewers and provide an audit trail of these comments. In discussions with users, we have learned that difficulties and bottlenecks often occur in consolidating and incorporating reviewer comments. For example, it is not unusual for multiple reviewers to have comments on the same portion of a draft product, which leaves the assignment staff responsible for resolving conflicting comments.

- Evaluators are required to complete a myriad of paperwork to process a report, including internal routing forms, external coordination forms, report distribution forms, and so on. The use of specialized forms automation and network-based data base management software would allow us to capture, process, and provide real-time information that could facilitate the processing of our reports.

Benefits of Automating This Process

The potential benefits of automating the report review process include increased productivity by reducing the time a product spends in the process and reduced frustration by providing staff with timely information on the status of their draft reports. Automation would also improve the quality of our reports by providing staff with writing tools to assist them with report preparation. Ultimately, the Congress will benefit by receiving our work on a more timely basis.

Job and Unit Management

The individual job assignment, whether it be an audit, program evaluation, or compliance review is the principle means for meeting GAO's mission objectives. Numerous individuals are involved in job management, including the evaluator-in-charge who manages the day-to-day tasks being performed to achieve our assignment objectives, an assistant director who has cognizant responsibility for the assignment and ensures office policy is followed, and the issue-area director who is responsible for integrating the assignment into an overall work plan. Managing these assignments requires that job managers be well-informed about an assignment's status so their decisions can be relevant and timely. There is a constant need to maintain up-to-date knowledge to ensure that proper job direction is provided and the numerous administrative forms required throughout the assignment are completed.

Unit managers typically fill such roles as assistant director, issue-area director, director for operations and director for planning and reporting. They are responsible for directing large blocks of related work, or for directing the activities of a work unit, region or division. They require timely access to accurate information on such issues as job performance and progress, budget status, and training needs.

Under the Shared Resources Project, we identified and evaluated ways to electronically collect and disseminate the information necessary to manage both a unit and specific assignments. We found that in a networked environment we can improve the quality of, and access to, information that managers need in order to be effective in performing their tasks.

Historical Perspective

In the current GAO environment, both assignment and unit management is dependent on paper and on communication. In planning and initiating an assignment, a number of administrative forms need to be prepared and forwarded through various levels of review. As an assignment proceeds, its status is tracked through additional administrative forms that provide information on staff-day usage, cost, and milestones. These forms must also go through a number of reviews throughout the organization. To update these forms with current information, evaluators-in-charge and assistant directors need to solicit information from the various staff on the assignment. This process becomes more tedious and cumbersome if assignment staff are located in a regional office or at a remote audit site. In these instances, making contact with staff while playing "phone tag" is very time-consuming and frustrating.

Unit management incurs similar constraints but on a much broader scale. Although many of the divisions now have automated management information systems, they are still dependent on relevant information obtained from staff to prepare the various forms for input. In addition, many issue-area directors need to track staff and assignments at various remote audit sites, both locally and across the nation. Their ability to get timely and relevant information is dependent on how easily they can make contact with the appropriate staff. This process becomes particularly demanding if staff are located in different time zones.

Activities to Date

Within the units participating in the Shared Resources Project, the network has become an important, necessary tool to manage the day-to-day operations involved in running a division and in managing the substantive needs of individual assignments. The network has greatly enhanced job and unit managers' ability to monitor projects and communicate with staff, although these functions were not specified within the project, and has generally made many of their operations more efficient.

In responding to a questionnaire we provided to staff in the three participating units, at least 70 percent of the management level officials who responded stated they increased the quality of their work by using the network. Over 80 percent stated the timeliness of their work increased, as well.

During the past year, seven different assignments used the network under the Shared Resources Project to perform specific job tasks. Included in these assignments were staff from two headquarters divisions, three regional offices, and various remote audit sites. In addition, several managers in the Human Resources Division and the Resources, Community, and Economic Development Division used the network to perform various managerial functions.

Benefits that enhanced communication and improved access among staff at all levels appeared immediately. One issue area director stated that the message feature was "a significant, invaluable tool and essential for operations." It greatly improved their ability to exchange information, and the ability to forward messages and send copies saved considerable time. Some directors believe an electronic message feature can flatten out the organization because it gives everyone direct access to everyone else who is on the system.

As a management tool, the network also allowed managers to have immediate access to workpapers regardless of location. This feature expedited their review and saved the cost of copying the material and physically sending it in for review. Assignment managers used the network to transmit quickly to division management the paperwork initiating an assignment, and in turn were able to receive approval much faster to begin the assignment. They also used the network to send in survey results and implementation-phase paperwork for quicker review and approval.

Division management also found it invaluable to send, for review and approval through the division, the various administrative forms that are required on a daily basis, such as OCR memos and job-start paperwork. Virtually all unit managers we spoke with stated how they use the network daily to conduct either some or all of their work. The message feature also improved their ability to respond quickly and more efficiently to various job inquiries from top officials. One issue-area director stated that the message feature alone has cut down his phone calls by 50 percent and that he now only receives "crisis calls." Other directors noted that the network eliminates the need to watch the clock when dealing with regional staff, because they can contact them at any time to relay important information. They also stated how regional office staff were able to keep division management informed about the work they were doing, which in turn helped expedite decisions on specific assignments.

Other managers used the calendar feature of the network to schedule both their meetings and absences. This allowed their staff to know their availability at any point in time.

Requirements

During the past year, assignment and unit managers in the participating units have come to rely on the network to perform various managerial functions in a more timely and efficient manner. However, by incorporating the network into their daily routine they were also able to identify limitations in the system that hampered their work. These limitations have, in turn, helped us to identify requirements that assignment and unit managers believe are necessary to achieve a fully operational, networked system.

In general, for the network to be effective, there must be "full membership" for all staff. That is, all staff must have direct access to the network and communication must be fast and without interruption. The

network interface also needs to be intuitive so that learning new functions on the system is easy.

To enhance specific assignment and unit management operations, staff using the network should have the ability to

- transfer multiple files quickly and easily with the ability to merge files among different job codes;
- use keyword and string searching to access supporting documentation;
- bring files up on to the screen for review and comment without having to download the file from the system;
- review workpapers and important documentation concurrently from various locations;
- communicate quickly and easily through an E-mail function with other staff both locally and, more importantly, at remote locations;
- access all workpaper files through a clearance procedure tied to a staff member's position, which will prevent certain sensitive documents from being obtained by unauthorized staff; and
- track supervisory reviews and the required follow-ups to ensure that the audit work being performed is of high quality.

Benefits of Automating This Process

Under the Shared Resources Project, GAO is moving to a networked environment that will dramatically improve the sharing of information and substantially improve the management of our work. Not only will very labor-intensive phases be supplemented with new information technology, but currently automated processes, such as Management Information Systems, will be made far more comprehensive and efficient.

In a network environment, managers will have ready access to relevant information, be able to prepare automated administrative forms at their individual workstations, share and send this information to all appropriate staff, communicate more effectively with various staff and management officials, and respond quickly to inquiries on training needs, assignment costs, and other work related issues. By having this access, productivity can be enhanced both on specific assignments and in unit operations.

Specifically, a fully integrated network can provide

- the ability to integrate information systems into the network so that job managers can have immediate access to the information necessary to track their assignments;

- access to managers for assignment tracking systems;
- quick access to electronically generated documents, such as workpapers, for review;
- improved access to other managers and staff through a greatly enhanced communications link;
- data bases that can be shared on such issues as training, awards, etc; and
- access for staff to many different kinds and sources of data such as the Health Information System or Energy data bases.

Supervisory oversight, at all levels, would also be increased by the network since supervisors would have immediate access to the work being done (if done electronically). The supervisor could monitor progress and quickly take any needed corrective actions.

Under the Shared Resources Project, we are moving to a networked environment that will allow us to make substantial improvements in managing the substance of our work. Not only will the very labor-intensive phases of our work be supplemented with new information technology, but currently automated processes, such as Management Information Systems, will be made far more comprehensive and efficient.

In a network environment, managers will have ready access to relevant information, be able to prepare automated administrative forms at their individual workstations, share and send this information to all appropriate staff, communicate more effectively with various staff and management officials, and respond quickly to inquiries on training needs, assignment costs, and other work issues. In the end, productivity will be enhanced, and the management of both specific assignments and unit operations will become more efficient and effective.

Network Configuration, Management and Security

In November 1989, GAO initiated the Shared Resources Project to identify methods of improving the way we do our work through automation. A system of local and wide area networks provided a vehicle for developing, testing, and evaluating new mission-related applications. The project was not intended to test the benefits of using a local area network, or to test the specific network that GAO had in place. However, as the project staff worked in a network environment during the past year, we came to better understand the strengths and limitations of networking in general, and of the particular configuration GAO was using. We also gained an education in related operational issues, including network management and security. These experiences have helped us more accurately define the technical and operating requirements of a GAO-wide network.

Network Configuration

The network consists of five elements

- system equipment (hardware), including the most appropriate type of workstations, file servers, printers, and other peripherals (i.e., scanners, back-up devices, etc.);
- a network operating system (software), including the user interface and basic file storage and handling functions;
- telecommunications (cabling), including the method of network access (e.g., hard-wired or dial-up) and the speed of response;
- security, including methods of controlling access and safeguarding the equipment and files; and
- management, including operational monitoring, technical support, and maintenance.

These components are intrinsically intertwined to provide a vehicle for automated group applications.

Historical Perspective

GAO's use of personal computer technology has grown and evolved steadily because of industry advances and an ever-improving view of our automated needs. GAO began using personal computers in 1982 to satisfy word-processing needs. Microcomputers, capable of performing a variety of automated functions, were integrated into the work place in 1984 and eventually replaced the single-function word processors. Today, the use of microcomputers to meet daily job requirements has

become commonplace.[1] Complex data analysis and even report production has been assisted by the use of stand-alone microprocessors. However, since sharing and consolidating information is a fundamental aspect of our work, staff proficiency in using automated tools in a stand-alone environment quickly became a constraint rather than an advantage. The efficiencies of using microcomputers to complete assignments were reduced by the need to share information through a "sneaker network" (i.e., hand carried). Our current focus has naturally shifted to a means of connecting users in an automated environment.

Objectives

Improved work quality and timeliness are GAO's ultimate goals; automation simply provides a potential means to that end. Networking, in turn, promises improvements to stand-alone automated applications. If our goal is to travel from point A to point B, automation provides a possible road to travel on. That road can be a two-lane highway (i.e., stand-alone microcomputers), or a superhighway (i.e., an automated network). The applications that are available on the network will ultimately provide the vehicles to reach our goals. However, those vehicles and the roads on which we use them are necessarily interrelated. A better network allows the development and use of stronger application tools. It is, therefore, important to continually define and refine the appropriate network for agencywide implementation.

Activities to Date

Installing a Network

In order to identify the proper requirements for an agencywide network environment, we have studied local area networks in a systematic, controlled manner. The San Francisco regional staff had experimented with the use of a small local area network supported by a Data General 8000 minicomputer as early as January 1988. On the basis of this early success, the Shared Resources Project expanded the trial structure in November 1989 to include two headquarters units, the Human Resources Division and the Resources, Community, and Economic Development Division. These units were serviced by a Data General 20000 minicomputer and two remote audit sites, one at the Social Security Administration, and the other at the Health Care Finance Administration, were serviced by a Data General 7800 minicomputer.

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[1]According to a survey of Shared Resources Project staff, over 96 percent used microcomputers during fiscal year 1990 to perform a portion of their GAO duties.

The type of workstation and operating software used to access the network varied among users. Although these differences created some disadvantages, they allowed us to identify system requirements that we might not have observed otherwise. In San Francisco, 125 staff had access to the local area network through a combination of personal microcomputers and dedicated Data General terminals. Depending on the equipment being used, operating software included CEO, CEO/Connect, and Data General's Personal Computer/Work Station (PCWS). For the divisions, over 300 staff had access to the local area network through microcomputers which were directly connected to the network (i.e., "hard-wired"). An additional 700 accounts were established for users to "dial-in" to the network from remote locations through modems. This latter group included staff outside the pilot divisions who were working on division assignments. Here again, a mixture of CEO/Connect and PCWS software provided user interface, depending on the equipment.

Communication links also varied. Hard-wired users were linked to the network through an Ethernet 802.3 architecture. Data transmissions occur at a speed approximating 9600 baud. Dial-up users gained access to the network through modems and the use of terminal emulation software. Their transmission speed was controlled by the limits of their workstation's modem—either 1200 or 2400 baud. The individual minicomputers, which act as file and communication servers for their respective user populations, are capable of communicating with each other through the Tymnet communication network. Communication between servers occurs at 9600 baud.

Identifying Requirements

A number of early operational problems arose in implementing this network. User access was unreliable, operation was erratic, and functionality was inconsistent. Shared Resources Project staff expended considerable effort to isolate the sources of the deficiencies. Independent consultants were also brought in to identify the causes of system inadequacies. We determined that the network was in compliance with the 802.3 standards for Ethernet, which ruled out cabling as the source of the problem. We also ruled out workstation hardware as the impeding factor. Ultimately, we determined that the Data General environment itself contained several impediments, both hardware and software related, to fully meeting our needs. As a result of this diagnostic work, the project team documented 30 functional requirements for a future agencywide system. The requirements cover general areas as well as specific applications that GAO requires to meet its mission. We further

determined that the current Data General environment was not capable of satisfying several of these mandatory requirements.

What We Have Learned So Far

The Shared Resources Project has contributed significantly to GAO's understanding of the hardware and software requirements for an agencywide network. In addition, we have gained valuable knowledge in defining our needs in operational areas such as network management and security. While our network requirements cover a broad range of issues, it is clear that the network's value is closely related to two factors — access on demand and ease of use.

Access on Demand

Staff must have network access on demand. This requires that appropriate workstations, telecommunications links, and network processors be available whenever needed. The frustrations and inefficiencies of accessing the network through a workstation that is shared with other users or physically located away from a user's normal work area are significant enough to discourage its use. In fact, 30 percent of the Shared Resources Project staff who do not have workstations dedicated to their use failed to use the LAN during the past year. This number compares with only 13 percent of those who have dedicated access to a workstation. In response to our survey of LAN use, the most common concern expressed (by a 4-to-1 margin) was the lack of workstations to access the network. This problem can be solved with a workstation-to-staff ratio of 1 to 1.

Closely related to the need for workstations is the need for a continually available link to the network. This need specifically concerns users who "dial-up" the network through modems. Since the modem requires a connection to a telephone line, it is currently common for staff to have to disconnect a voice line to use with the workstation. This ties up the voice line for the period of network use. At many locations a telephone line may be shared by several staff, so using a workstation can restrict the communications of more than just the network user.

Access on demand also requires system availability 24-hours a day, seven days a week. Given a workstation and a communication link (i.e., a telephone line), the network must be operational whenever staff attempt to access it. Ideally, the system should maintain a reliability level near 100 percent. Practically, the system must deal with periodic failures without disabling the entire network. Extensive or frequent downtime caused by equipment failures, backup functions, or system maintenance procedures interferes with users' ability to complete their

work. This interference, in turn, prompts users to avoid or limit their use of the network. When asked why they would choose to complete automated activities in a stand-alone rather than a networked environment, 16 percent of respondents cited poor system reliability as a factor.

Providing continual access means having a system with built-in backup capacity and an ability to segregate system failures and minimize their effects on users. The current configuration concentrates users on a few high-powered servers. This means that a system failure affects large numbers of users. When a server is down, users must wait for it to be repaired before regaining network access. Even routine maintenance requires a complete shut-down of the server, thus blocking usage by that user community. An agencywide system must have the ability to shut down a portion of the system, while maintaining user access through other operating servers.

Finally, all users must have equal access to the network. The current system creates functional differences between hard-wired users and those who dial into the system. In fact, because of system constraints and limitations on transmission speed, dial-in users currently have no access to the application programs, such as word processing and data analysis, that are available to hard-wired users. An agencywide network must provide full membership rights to all users, regardless of their method of access.

Ease of Use

This requirement was made clear by the current environment because of its highly proprietary nature. Although meeting basic Ethernet requirements, the uncommon operating system did not function properly with many software applications developed for LAN use, and it proved complex to use. We attribute this complexity to the fact that the system was originally designed for minicomputer operations, and was not redesigned for network use.

File sharing and transfer is a good example of "ease of use" problems with the current network. While these functions were among the most valuable on the network, the file naming conventions and other unique system requirements made their use cumbersome. In some cases, documents had to be moved between different computer systems when sharing data or transferring files. Transferring multiple documents, a common requirement, was also a difficult task. As a result, only 18 percent of those who used the network performed file sharing on a regular basis, and only 28 percent made regular use of the file transfer feature.

Without a well-integrated system that is easy to use, staff become reluctant to use the full range of automated functions, and do not take full advantage of computers in their day-to-day operations. The ideal integrated system should enable the user to concentrate on auditing and evaluation tasks, while minimizing the effort needed to operate the computer system. The system should permit the user to switch easily between applications such as word processing, E-mail, and document filing with a minimum of effort (two or three keystrokes).

Ease of use also includes appropriate system responsiveness. Staff on the pilot experienced significant frustration waiting for menus to appear and functions to be executed. While these delays in themselves were not sufficient to impair the timeliness of the process being performed, the frustration they caused did. Staff would at times terminate functions they were performing because of the delays.

On the basis of our experience with the PCWS and CEO menus, it appeared that response times under 2 seconds were satisfactory.[2] Though such delays are noticeable, they did not frustrate the operator. At this speed, staff did not discontinue using the automated system. Since communication links are one factor in determining response time, the network must have the telecommunication capability to support this level of responsiveness.

In essence, an agencywide network should be standard. Network components must

- conform to the formal standards developed by official bodies (e.g., IEEE 802.3 standards);
- be compatible with other hardware and software on the network so that users can interact easily; and
- be within the mainstream of hardware and operating systems (i.e., de facto industry standards) so that the agency can benefit from third-party development efforts.

Need for a Distributed Network

Many of our current problems with access and ease of use can be reduced by a fundamental change in the system configuration. Instead of the current centralized system, a distributed network would best meet

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[2]The 2-second response time should be evaluated using a sample of staff to determine if it is adequate. Some staff believe this criteria is too slow.

our operational requirements. This concept parallels GAO's highly decentralized organizational structure. Operating groups often work independently of each other. GAO units investigate different areas, use different methodologies and procedures, and require different tools. As a result, they must be able to customize their network services to meet their unique needs. A network of discrete segments, having an ability to pass information throughout the entire network, will meet these needs.

A decentralized environment provides several other inherent benefits. The presence of multiple servers within the overall network configuration creates a level of built-in backup support. This support reduces the impact of a server failure and minimizes network downtime. By confining LAN segments to individual organizational entities, greater ownership of the materials and system are created. In addition, an improved understanding of network management requirements is gained.

In meeting this distributed scheme, we have learned that the "super servers" that evolved out of microcomputer technology would provide a stronger, more stable platform for an agencywide network than minicomputers. Minicomputers were not originally designed to act as servers on networks using intelligent workstations. Rather, they were developed to provide host support in a terminal environment, where the central server contained all the intelligence and did all the work. Although minicomputer servers now provide PC-networking functions, they bring with them a significant operating system overhead and inappropriate filing structures. Microcomputer super servers, on the other hand, were designed for an environment in which intelligence is distributed throughout the network. As a result, they avoid the large overhead found on minicomputers by using the power of the workstation as an essential element in the total architecture. They provide, therefore, both a richer and more flexible environment that allows for modular growth on existing networks.

Network Management

Ensuring adequate access, ease of use, and proper network growth requires continual network management. Our experiences have shown that network management involves much more than we anticipated at the outset. It is a full-time activity that should be separated from other objectives such as application development. In a complete sense, network management is a complex series of interrelated tasks involving

- planning and configuration development,
- operating and procedures development,

- performance monitoring and optimization,
- troubleshooting,
- maintenance,
- end-user requirements definition,
- selection and testing of new user tools, and
- support of network operators and end users.

Because network management covers such a broad area, it requires a staff with diverse skills. In addition to specialized skills in areas such as telecommunications and capacity planning, network managers must have good interpersonal skills because so much of their activity will directly affect users. Adequate resources must be dedicated to this function. If the staffing level is not adequate, network services will be reduced and end users will become frustrated and cease to use the network.

System Security

Since the network will contain sensitive data, it must conform to the guidelines outlined in 4CFR81 (Public Availability of General Accounting Office Records) and 4CFR83 (Privacy Procedures for Personnel Records). Specifically, requirements include

- physical and fire protection for servers and major components,
- electrical conditioning for the servers,
- established back-up procedures,
- off-site storage for back-up copies of files and data,
- password protection for network access,
- administrative controls to purge staff who no longer access the network or who may pose a security threat to it,
- access controls for files at the individual level, and
- protection from viruses.

The Shared Resources Project has also completed a four-step process for addressing the computer security requirements of a GAO-wide network. First, a network security plan was drafted and used to develop network operating procedures. The project team then reviewed the security provided by the operating system and application programs to determine their adequacy. In March/April 1990 a formal security review was performed by an outside contractor. Finally, GAO worked with security consultants to develop protection from computer viruses. A GAO-wide network must meet the security requirements identified through this process.

Current and Future Actions

On the basis of the lessons we have learned during the past year, we have taken several steps to improve progress toward a GAO-wide network, including proposed changes in the technical configuration of the network, network management, and central administration.

New Network Configuration

The GAO network will move from a centralized structure that functions as a single backbone, through a multiport repeater, to a decentralized system of discrete LAN segments. Each segment will employ its own servers, backup devices, accounts, applications software, and network management.

The current Data General minicomputers will be replaced as LAN servers by 80386 microcomputers running a Novell operating system. Since Novell currently covers about 60 percent of the network installations in the industry, its hardware/software combination provides a high degree of compatibility with a large number of application software products. This combination will also provide a common user interface and functionality regardless of how the user enters the network, whether through a hard-wired or dial-up feature.

Network Management

To address the need for high-quality network management, GAO is in the process of hiring a network manager who will have responsibility for all network-related activities throughout the agency. This individual will oversee the development of a formal requirements statement, the initiation and completion of a procurement action, and the ultimate implementation of the agencywide system. Central administration of network activities will also be moved from the Shared Resources Project team to the network manager.

Standard and Policy Setting

GAO recognizes that implementing a high-performing computer network requires more than selecting the correct equipment and application programs. The decentralized system being proposed permits unit flexibility in the network operation. However, a degree of central control is necessary to ensure that users and data on individual LAN segments can interact with other LAN segments. Representatives from various GAO organizations have been brought together into a standards committee for this purpose. Their role will be to establish agencywide parameters that will ensure continuity among operating units. They will, where appropriate, create common applications and procedures across the distributed network.

In addition, we understand that implementation of the network will define new ways of accomplishing our work. As a result, a wide range of policy issues will certainly arise. Needed policies must be identified and put in place as network implementation is occurring. To ensure that policy issues are addressed in a timely manner, the Assistant Comptroller General for Policy is a member of the IRM Advisory Committee. In addition, GAO's Office of Policy has created and filled a new position of Technical Policy Adviser to provide the needed technical expertise in developing appropriate policies.

Training

The ever-increasing complexity of GAO's work requires us to continually seek opportunities to expand our skills and to acquire new ones. We are facing expanding challenges to conduct new kinds of work, use new methods, contend with technological advances, and review complex government programs that address national issues. Keeping GAO's training in step with evolving computer technology and the changes resulting from it is crucial to the success we achieve in meeting these challenges. As a result, consideration of training needs is an important part of GAO's Shared Resources Project.

Historical Perspective

In the current environment, technical and information management training is largely provided to GAO staff in the form of classroom training, both internally and externally. Some of the inherent limitations of this convention are: (1) individuals must schedule training, disrupt their work, and sit through entire sessions which sometimes cover many skills already possessed; (2) the instructor has to satisfy the training needs of students with a wide diversity of expertise both in skill level and learning ability; and (3) in many technical courses, especially software applications (word processing, spreadsheet, data base) and analytical process training, little-used features and procedures are quickly forgotten.

Refresher training or brush-up of some sort is required when the need for a skill arises in the course of a particular assignment. This training disrupts work and slows productivity. GAO staff would rather have short demonstrations of how to use an automated system and then be able to practice on their own. On-line training, on-line help screens, "cheat" or summary sheets, and a help line would enhance the staff's ability to improve existing skills or learn new ones.

We have taken a number of initiatives during recent years to ensure that our staff stays responsive to the rapidly evolving nature of our work and the skills required to do it. For example, we established the Training Institute in May 1988, set up a curriculum advisory committee to keep course content responsive to office needs, and made the director of the Training Institute a member of the Information Resources Management Steering Committee. We have also introduced computer technology in noncomputer training (e.g., using microcomputers in writing or statistics courses) and have provided specialized training for staff involved in technical work such as information technology and accounting. In addition, we are exploring ways to greatly expand our self-paced training

capability through a variety of modes including diskette, interactive video, and tutorials.

These initiatives played an integral part in bringing information technology into the organization and have allowed us to enhance the overall quality and productivity of GAO staff.

Activities to Date

Our experience during the pilot project has disclosed that users who (1) encounter consistent difficulties accessing or using the network's applications, (2) find it more difficult or time-consuming to use the network over manual methods or a stand-alone microcomputer, and (3) have not received timely training and need to refer to lengthy reference manuals, experience a high degree of frustration. This frustration leads to reluctance by some staff to use the network.

As a result, the Training Institute is developing a Training/Performance Support System that will be an integral part of a shared-resource processing environment. It will offer the potential to significantly increase productivity by reducing the inherent frustration that often accompanies removing staff from their work sites to be trained.

Training/Performance Support is a concept made possible by technology. A performance support system is an integrated electronic environment that is available to, and easily accessible by, each employee. It is structured to provide immediate, individualized, on-line access to the full range of information, software, guidance, advice and assistance, data, images, tools, and assessment and monitoring systems that help employees perform their jobs with a minimum of support and intervention by others. Users can enter the system either at the level of difficulty needed for their work or at their personal level of expertise.

In the context of the Shared Resources Project a Training/Performance Support System will include all the support needed by an evaluator to perform the full range of report processing and oversight. For example, as part of an audit, evaluators would have immediately available at their workstations information, examples, and aids on how to prepare electronic workpapers, along with information on policies, processes, and forms needed to perform that function properly.

During recent months, we validated our Training/Performance Support System concept with pilot participants and potential users by interviewing key players in the project divisions and cognizant offices. The

validation process confirmed the basic elements of user support needed to perform rudimentary audit work (e.g., processing reports). We also observed training/performance support initiatives at other agencies and organizations to obtain the benefits of their experience in that area. In addition, we reviewed pertinent literature, and had vendors demonstrate software applications that were generic to the concept.

Activities Planned

During fiscal year 1991, we plan to design and prototype a "breadboard" Training/Performance Support System. We will take the key functional requirements (e.g., workpapers, report processing, etc.) developed by the other project members and build a prototype Training/ Performance Support System around each of them. Ideally, each key functional requirement (and related elements of GAO audit work) will be systematically integrated with an easy-to-use interface.

This development effort will focus on automated workpapers, indexing, report processing, forms, reference manuals, computer-based training, key indicators, job tracking, and other areas. Applications that help us perform our audit work will receive top priority. Feasibility, cost, and technology will influence our priorities.

A key to the success of this aspect of the project will be the integration of the shared-resource applications and on-line assistance/help with an easy-to-understand and use interface. This interface must allow users to move quickly and easily between any application and its associated support.

Following this prototype we will install the Training/Performance Support System on the project network to further validate and refine the system. This investment will, in turn, allow GAO to prepare specifications for future integration of this technology in a GAO-wide network.

Requirements

Components needed for a fully integrated Training/Performance Support System include:

- Data bases holding the data a person needs or will manipulate in doing a job. These include

  traditional data bases such as numbers, graphs, libraries, and other data;

text data bases, including on-line documentation such as procedures, policy and product information, concepts and explanations, glossaries, commands, and stored images of text relevant to the job (studies, reports, etc.);

visual data bases, including libraries of pictures, schematics, graphics, maps, and full-motion video, to provide information or to serve as models, representative images, reference points, and so forth; and

audio data bases with libraries of sounds and word sequences, and music in a form that can be heard and understood by people.

- Information services, such as LEGIS.
- Interactive productivity software including spreadsheets, text processors, task-specific interactive job aids, and so on.
- Applications software to perform specific job tasks or functions (e.g., automated work papers, indexing, report review, management reporting systems, and case systems).
- Expert or artificial intelligence systems for problem structuring, decision support, analysis, and diagnosis.
- Help systems that are user or system initiated, context sensitive and inquiry based, or intelligent. Help systems can include explanations, demonstrations, advice, and alternatives.
- Interactive training programs that permit self-directed or structured learning experiences, which are task related and flexible.
- Assessment systems that permit evaluation of knowledge or skills for either task performance or assessing employee competence.
- Feedback and monitoring systems that can inform users about the appropriateness of their actions (e.g., error messages and related instructions), or track user activity to determine whether assistance is needed.
- A user interface that provides user-defined access to the above components in a straightforward and consistent way, and that permits the integration of relevant components so that a meaningful and whole context is provided for the user.

Benefits

An integrated Training/Performance Support System at an employee workstation has enormous implications for enhancing staff performance. Such a system could greatly reduce some on-the-job training by bringing the experience and expertise of the most skilled performer to all, thereby permitting staff with limited knowledge to successfully perform a job with minimal assistance. With performance support, learning

is driven and controlled by the user's information needs—needs that are directly related to job demands. By placing the responsibility for learning in the user's hands, it automatically accommodates his or her learning style and learning level.

Some of the specific benefits that would be realized under an operational Training/Performance Support System are:

- enhanced user productivity as a result of fewer disruptions in work,
- better quality of work through easy access to job aids,
- training tailored to individual and job needs,
- easier and more timely access to training, and
- consistent quality of training.

A fully automated, shared-resource processing environment using a local/wide area network, will not only change the way we train our staff but also greatly expand GAO's ability to deliver training and provide network user support. We believe the potentials of an agencywide network are great. Changes in training methodologies can improve network user competence and also improve productivity substantively.

Analysis of User Questionnaire

As part of our evaluation methodology, we sent out an extensive questionnaire (see appendix VII) to all staff in the three units participating in the Shared Resources Project — the Human Resources Division; the Resources, Community, and Economic Development Division; and the San Francisco Regional Office. The purpose of this questionnaire was to obtain information on local area network (LAN) usage, performance, and impact on job and management performance. To encourage candid answers, we did not identify individual respondents. In addition, to expedite the preparation and analysis of the data, we limited the response period to ten days. This appendix contains our analysis of the questionnaire responses.

A total of 558 questionnaires, from a population of 905 staff, were returned prior to the established cut-off date for a response rate of 61.7 percent. Of these respondents, 23 were eliminated because they had recently joined their GAO unit and had 3 months or less experience with the LAN. As a result, our analyses are based on a maximum respondent universe of 535.[3]

Figure 1: SRP User Questionnaire Response Rate

- NON-RESPONSES
- 38.3%
- 61.7% — RESPONSES
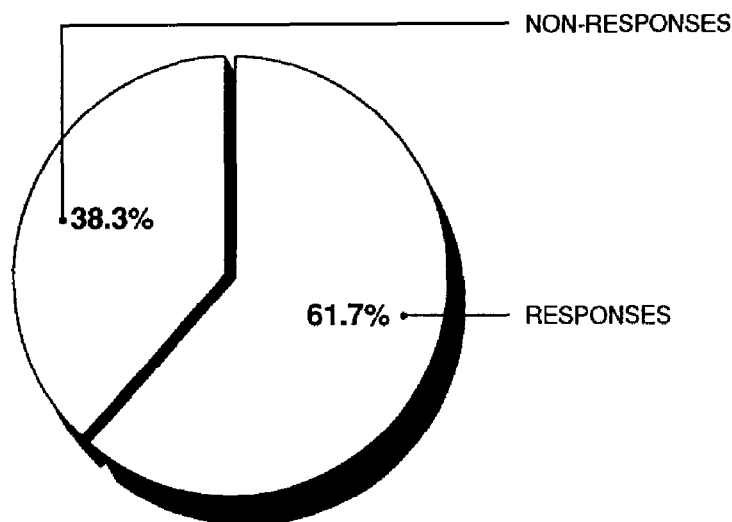
[3]Since not all users were required to answer all questions, the respondent universe will vary somewhat for each analysis.

Use of Microcomputers

Use of microcomputers among the questionnaire respondents was very high. A total of 517, or 96.6 percent, reported that they used a microcomputer during FY 1990 to perform at least some of their job tasks. Only 18 respondents (3.4 percent) indicated they did not use a microcomputer at all during the year.

**Figure 2: Staff Using Microcomputers in FY 1990 to Perform GAO Duties**

Percent

100

80

60

40

20

0

YES   NO
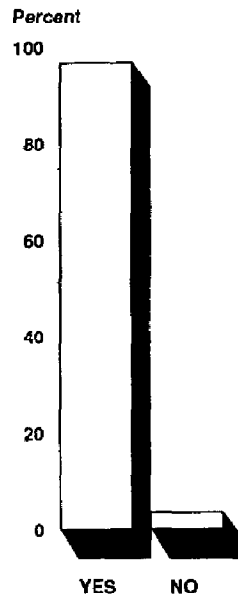
Use of the Local Area Network

Use of the local area network was also high among the respondent population. Although SRP staff had a choice of operating their microcomputers in a stand-alone environment or as a part of the local area network, 407 staff (78.8 percent) who said they used a microcomputer during FY 1990, indicated they used the network in performing at least a portion of their job tasks. The remaining 110 microcomputer users did not use the network during the year.

**Figure 3: Staff Using LAN in FY 1990 to Perform GAO Duties**
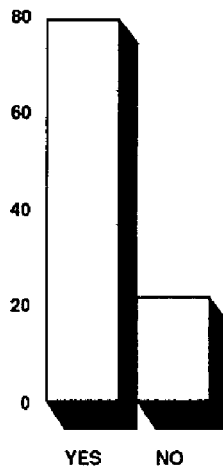
Frequency of LAN Use

Staff used the LAN to varying degrees during the past year. We grouped the 517 respondents to this question into three categories. Regular users are those who indicated they used the network for 50 percent or more of their activity. Occasional users employed the network for less than 50 percent of their activity; non-users never used the LAN during the past year.

Figure 4: Frequency of LAN Use for All Users

NEVER

21.2%   23%   REGULAR

55.8%

OCCASIONAL
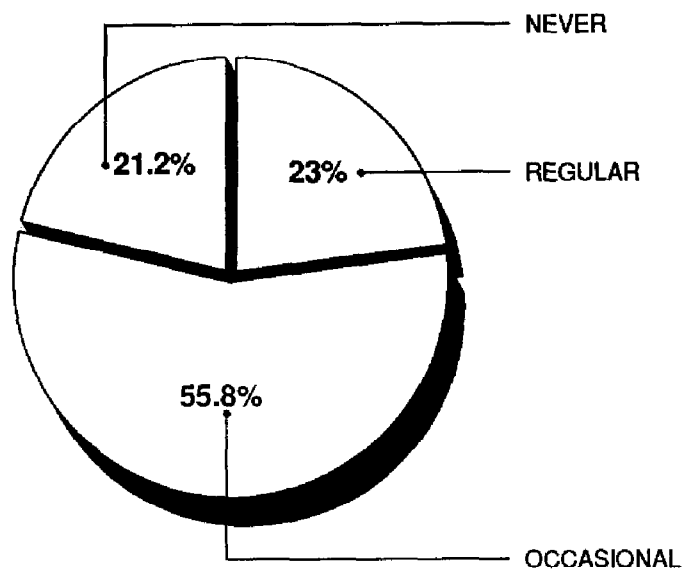
Factors Impacting on LAN Use

While some staff have equipment assigned to them on a full-time basis, current inventory levels require other staff to share workstations. We found that 30 percent of staff who had a microcomputer located in their own office made regular use of the LAN, compared to 16 percent of those having to share a workstation in a common area.

Figure 5: Frequency of LAN Use When Workstation is in User's Office
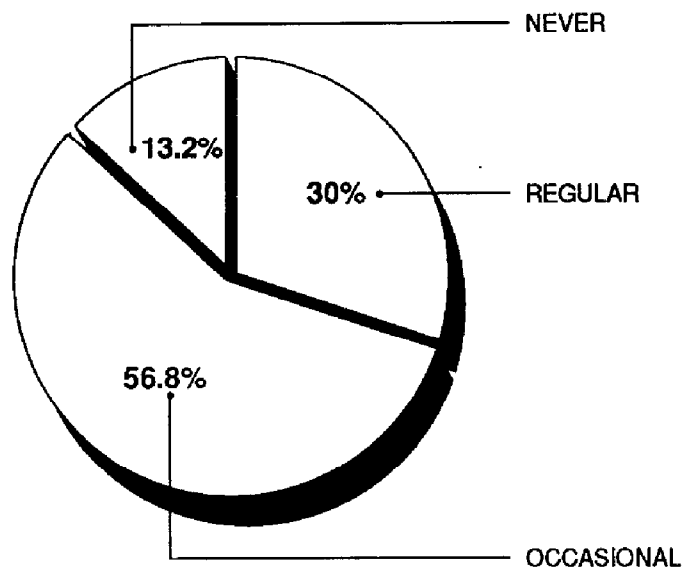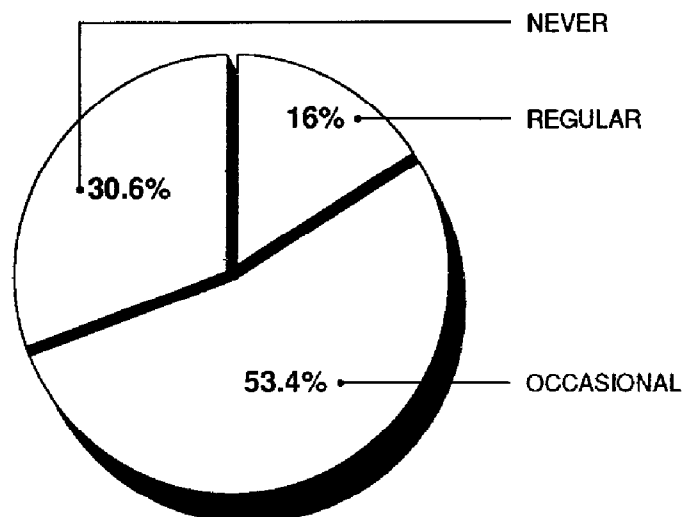

Figure 6: Frequency of LAN Use When Workstation is in a Common Area

Similarly, the current network configuration provides two means of connecting to the network. Users physically located near the network file servers (i.e., in the same building) are generally connected through a cable ("hard-wired"). Users located at remote sites create a connection through the use of a modem and an existing telephone line ("dial-up"). Questionnaire responses indicated that users whose workstation was hard-wired into the local area network were five times more likely to be a regular user than those who accessed through a dial-up method.

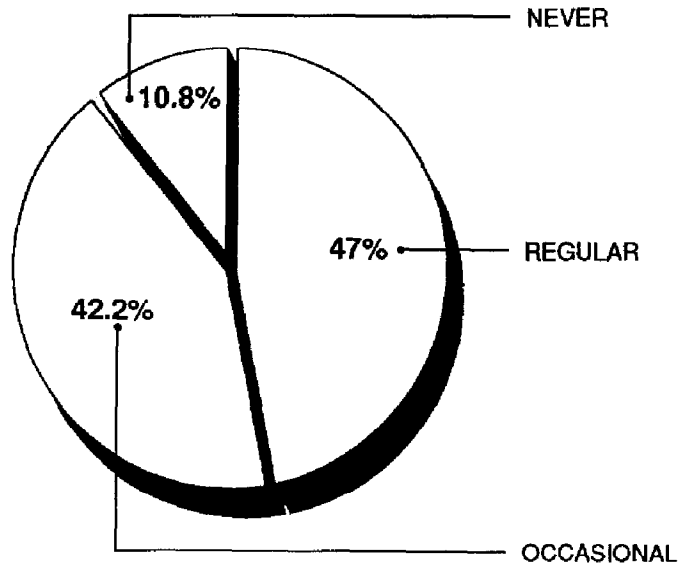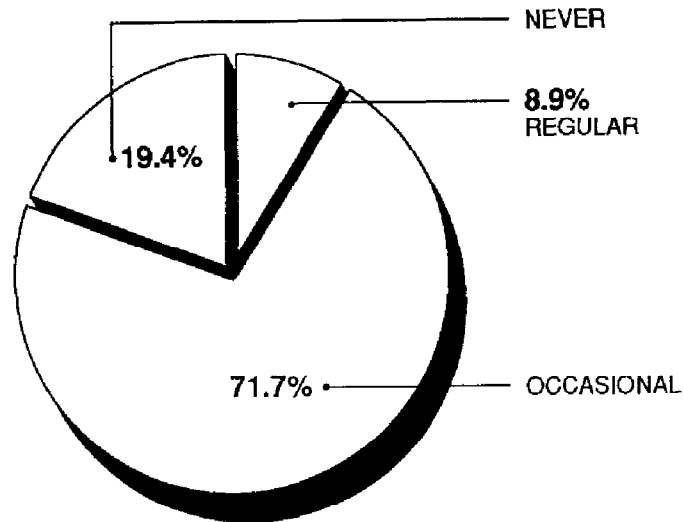**Figure 7: Frequency of LAN Use of Hard-Wired Users**

Figure 8: Frequency of LAN Use for Dial-Up Users

Frequency of LAN Use for Dial-Up Users

NEVER

8.9%
REGULAR

19.4%

71.7% •———— OCCASIONAL

Frequency of LAN Usage for Specific Tasks

We asked staff to indicate, within the five functions described below, the manner in which they used the LAN.

Messaging - sending or receiving messages.

File Sharing - providing common or shared access to electronic documents.

File Transfer - transmitting or receiving electronic documents.

Composition - creating or revising written materials.

Data Analysis - manipulating and examining data.

Based on 404 questionnaire responses, we grouped frequency of utilization into "regular" (i.e., several times a month or more) and "infrequent" (i.e., once a month or less).

Questionnaire responses show that in the past year staff used the LAN primarily for messaging. The utilization of the other functions is significantly lower due to limitations in the current hardware/software configuration.

Figure 9: Frequency of LAN Use for Various Functions

100 Percent

REGULAR

INFREQUENT
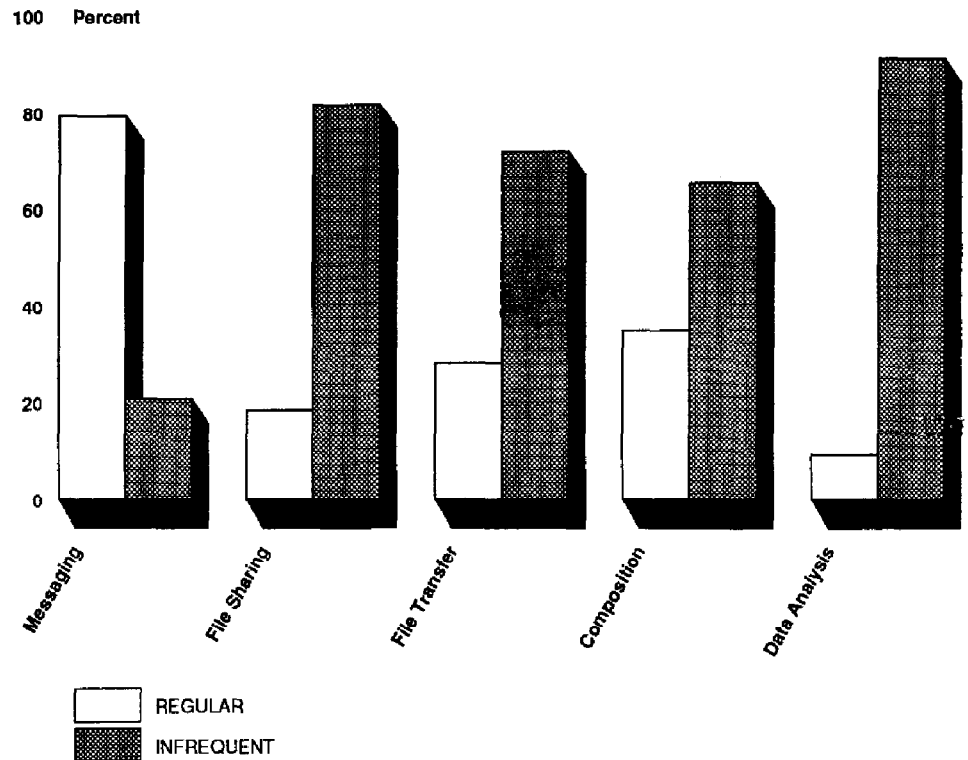
Impact of LAN on Areas of GAO Responsibility

We also asked those who had used the LAN during the past year to assess its impact on the timeliness and quality of their contributions to three areas

- job conduct, including assignment/issue area planning, data collection and analysis, report preparation and review, and product publishing and distribution;
- job management, including general management/oversight of individual or multiple assignments; and
- unit management, including obtaining, developing, and communicating information related to the tracking and scheduling of assignments and resources as well as training, travel, personnel information, and other management information.

Because not all GAO staff have responsibility for each of these areas, the frequency with which they used the LAN in each varied.
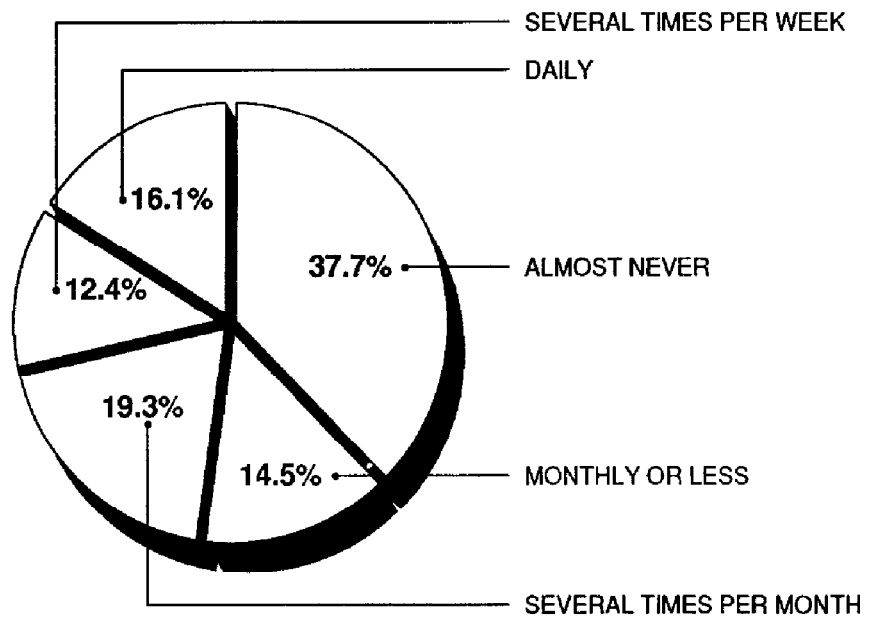
Figure 10: Frequency of LAN Use for Assignment Conduct

SEVERAL TIMES PER WEEK

DAILY

16.1%

12.4%

37.7% — ALMOST NEVER

19.3%

14.5% — MONTHLY OR LESS

SEVERAL TIMES PER MONTH

Figure 11: Frequency of LAN Use for Assignment Management

SEVERAL TIMES PER MONTH

7.5%
SEVERAL TIMES PER WEEK

7%
DAILY

45.1% — ALMOST NEVER

21%

19.4%

MONTHLY OR LESS
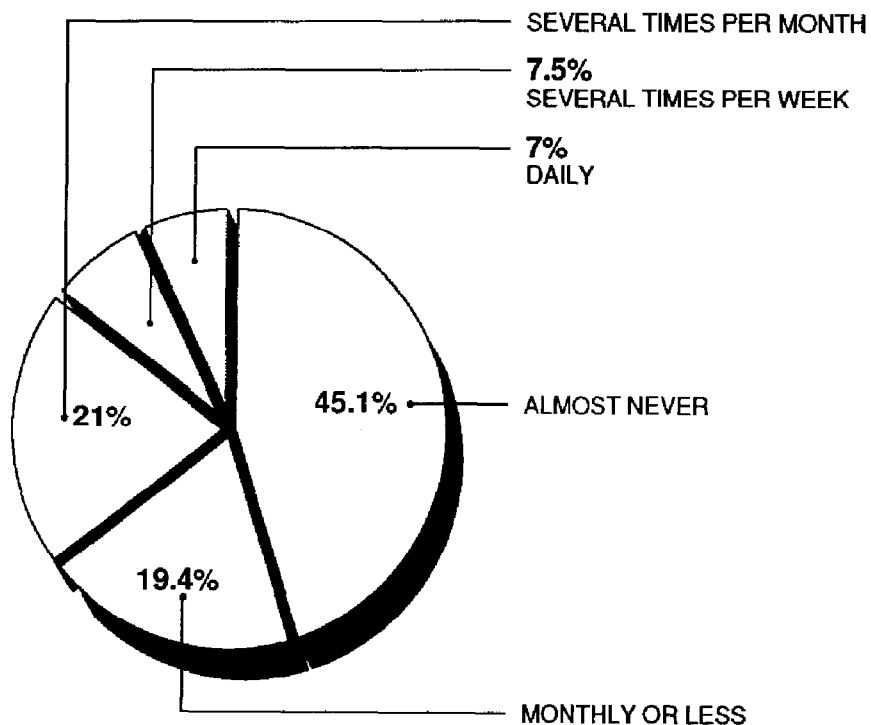
Figure 12: Frequency of LAN Use for Unit Management

SEVERAL TIMES PER WEEK

DAILY

19%

37.5% — ALMOST NEVER

11%

17.8%

14.7% — MONTHLY OR LESS

SEVERAL TIMES PER MONTH
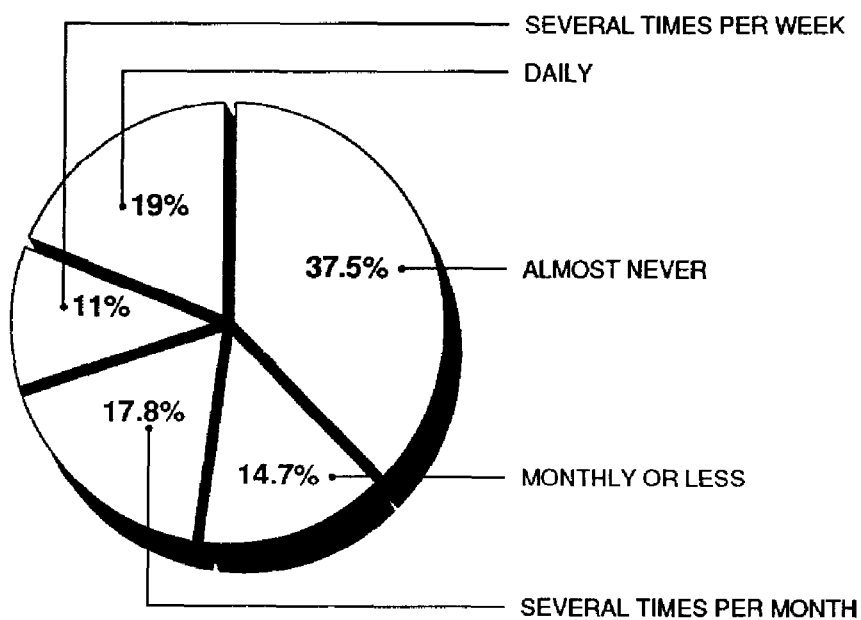
The staff who made use of the LAN at least weekly in any of these areas judged it to have a strongly positive impact on both the quality and timeliness of their contributions.

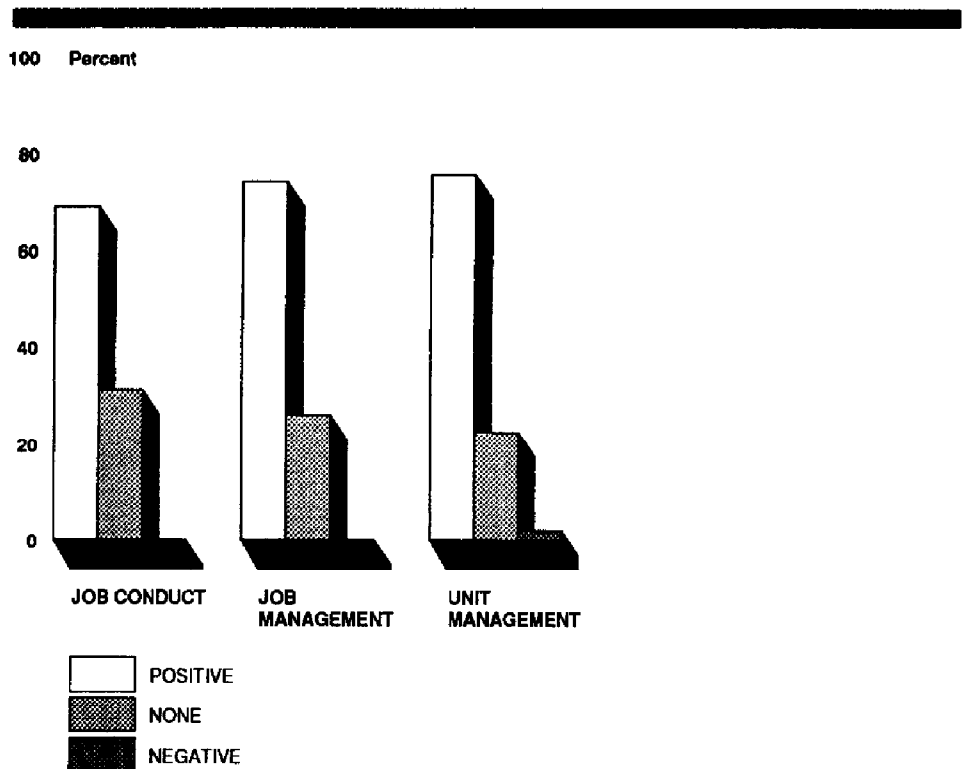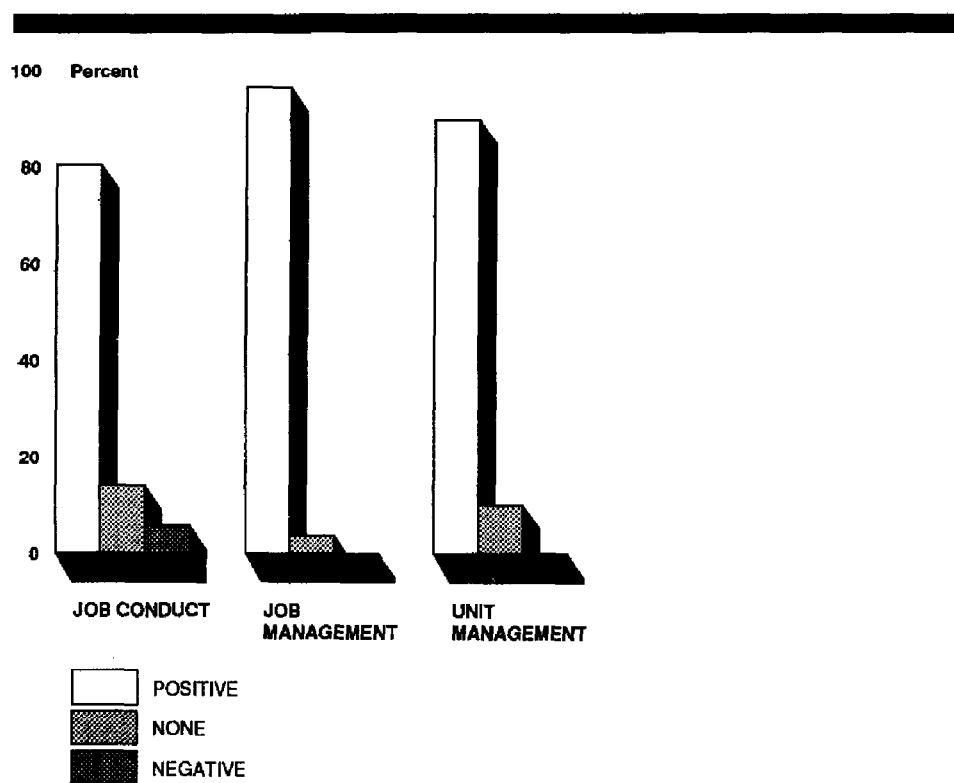**Figure 13: Impact of LAN on Quality (Weekly and Daily Users Only)**

100   Percent

JOB CONDUCT   JOB MANAGEMENT   UNIT MANAGEMENT

POSITIVE
NONE
NEGATIVE

**Figure 14: Impact of LAN on Timeliness
(Weekly and Daily Users Only)**

Other Areas Impacted by the LAN

After using the LAN for a period of time to perform various job tasks, users perceived a positive impact in a number of additional areas. Most prevalent was in communication with headquarters staff where almost 80 percent of the LAN users said it had a positive impact. About 60 percent of the users perceived a positive impact on their personal productivity, while at least 30 percent of LAN users believed the network has had a positive impact on areas such as personal morale and product quality.

Figure 15: Percentage of LAN Users Perceiving a Positive Impact of LAN on Various Areas
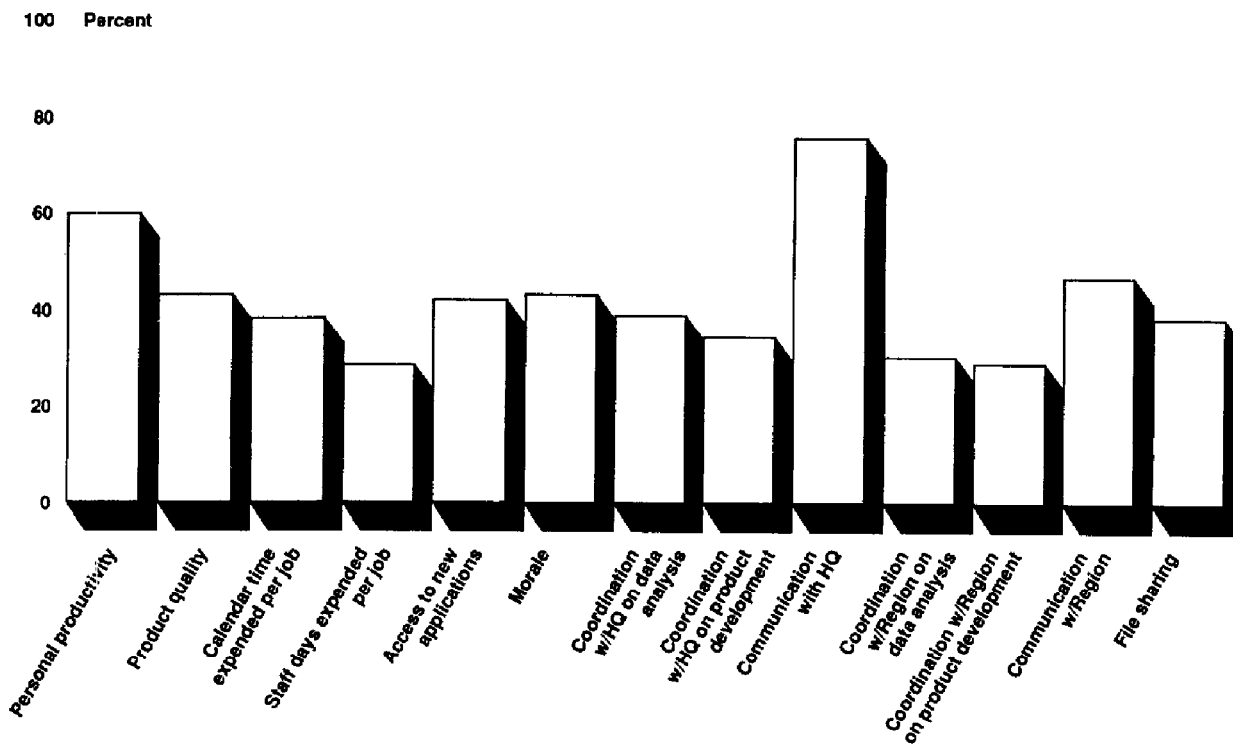
100 Percent

Reasons for Not Using the LAN

To better understand how the network could be improved to meet user needs, we asked staff why they would choose to use microcomputers in a stand-alone environment rather than in a LAN mode. Over 30 percent of the respondents indicated they did so because of the difficulty in accessing the LAN software. Other staff stated that the stand-alone environment was faster, that the LAN operation was too unreliable, or that LAN access was inadequate.

Figure 16: Reasons for Using Computers in Stand-alone Rather Than LAN Mode
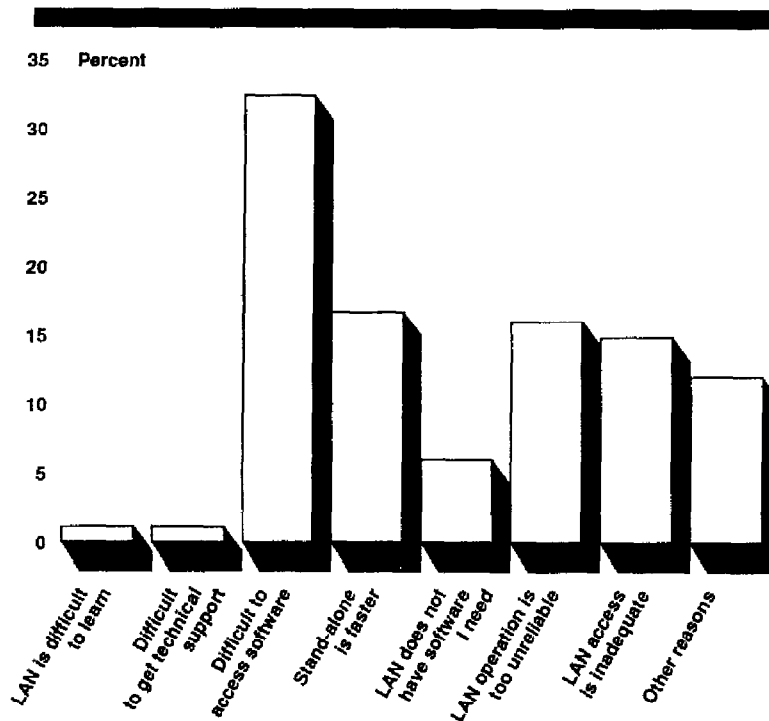
Adequacy of the Existing LAN

Finally, we asked users to assess the adequacy of various aspects of the LAN. Less than 70 percent of the respondents said they had adequate access to the LAN and less than 40 percent found the LAN to be operationally reliable. Only about 70 percent of the staff said they had adequate access to a computer.

Figure 17: LAN Users' Perception of Adequacy
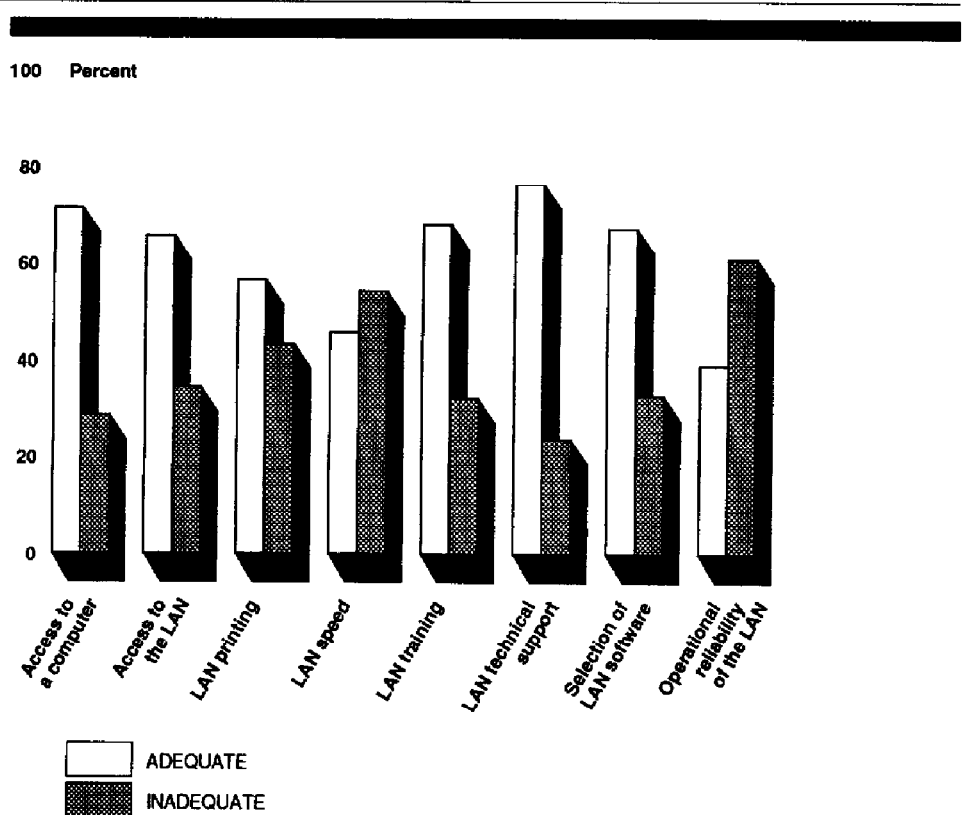
100   Percent

80

60

40

20

0

Access to a computer

Access to the LAN

LAN printing

LAN speed

LAN training

LAN technical support

Selection of LAN software

Operational reliability of the LAN

☐ ADEQUATE

▨ INADEQUATE

Network User Questionnaire

The purpose of this questionnaire is to obtain data on how computers are being used by staff and how they have affected our work. Specifically , this survey focuses on automated data processing and office automation resources in GAO, especially in environments where microcomputers are being networked together with a Local Area Network (LAN). As you may know, your office is part of a pilot looking at office automation. Your assistance in providing information will ultimately help us to make better decisions regarding the acquisition and application of technology resources in the future.

This questionnaire should take only a few minutes to complete. Thank you for your assistance.

PART 1-DEFINITIONS

For the purpose of this study, there are two computer environments: the LAN environment and the stand alone environment. A definition of each is provided below.

LAN Environment--Use of a microcomputer or terminal to access and use software packages such as WordPerfect, Foxbase+, Email, etc. through the local area network (LAN). The microcomputer/terminal may be physically cabled to the LAN or connected through a modem.

Stand Alone Environment--Use of a microcomputer to access and use software packages such as WordPerfect, dBase, etc. which are located either on a floppy diskette or the microcomputer's hard disk.

PART II-BACKGROUND INFORMATION

1. What is your current grade? *(Check one.)*

   1. [ ] GS-8 and below

   2. [ ] Band I/GS-9 to GS-12

   3. [ ] Band II/GS-13 and GS-14

   4. [ ] Band III/GS-15

   5. [ ] Above GS-15 and SES

2. What is your division or regional office? *(Check one.)*

   1. [ ] RCED (in headquarters building)

   2. [ ] Other RCED audit site

   3. [ ] HRD (in headquarters building)

   4. [ ] HRD/SSA site

   5. [ ] HRD/HCFA site

   6. [ ] Other HRD audit site

   7. [ ] San Francisco Regional Office

   8. [ ] Other GAO regional office

   9. [ ] OIRM, OPC, OGC or other

3. How many months have you worked in this division, regional office or other office? *(Enter number.)*

   _____months

4. Which of the following describes your function, regardless of your formal position description? *(Check one.)*

1. [ ] Clerical, secretarial, or administrative support

2. [ ] Evaluator or evaluator-related staff not in a specialist group

3. [ ] Specialist (DMTAG, TAG, or EAG member in a specialist group)

4. [ ] Unit manager (ACG, Director, Regional Manager, Assistant Director, etc.)

5. [ ] Other *(Specify.)* _____

_____

5. Where is the microcomputer/terminal you most frequently use? If you do not use a microcomputer/terminal, where is the one you would use if you did? *(Check one.)*

1. [ ] In your cubicle or office

2. [ ] In someone else's cubicle or office

3. [ ] In a shared or common area

6. Is this microcomputer/terminal hard-wired into the LAN or does it access the LAN through a modem? *(Check one.)*

1. [ ] Hard-wired into the LAN

2. [ ] Accesses the LAN through a modem

3. [ ] Not connected to the LAN in either way

7. Below is a list of software packages. In Part A, indicate how much working knowledge you have of each. In Part B, indicate how that knowledge level has changed during FY 1990. *(Check one box for each.)*

Part A
Current Working Knowledge

Part B
Change in Working Knowledge

SOFTWARE PACKAGES	None (1)	A little (2)	A moderate amount (3)	A great deal (4)	Increased (5)	Remained the Same (6)	Decreased (7)
1. WordPerfect							
2. Lotus							
3. dBase							
4. Foxbase +							
5. Statistical Analysis System (SAS)							
6. Statistical Package for the Social Sciences (SPSS) in the LAN environment							
7. SPSS in the stand-alone environment							
8. XTALK							
9. Email							

PART III-USAGE PATTERNS

8. *During fiscal year 1990, did you use a computer to do GAO work? (Check one.)*

    1. [ ] Yes

    2. [ ] No-->*(Skip to 18)*

9. *About what portion of the GAO work you did using a computer, was done through the LAN? (Check one.)*

    1. [ ] All or almost all

    2. [ ] Most

    3. [ ] About half

    4. [ ] Some

    5. [ ] Little

    6. [ ] None-->*(Skip to 15)*

Note: The following items concern the role computers play in selected functions and areas of responsibility associated with your GAO work. It is necessary that you read the related definitions before completing questions in this section.

<u>Functions</u>

Messaging--using the network to send or receive messages.

File Sharing--using the network to provide common or shared access to electronic documents.

File Transfer--using the network to transmit or receive electronic files.

Composition/editing--using network provided software to create or revise written material (i.e., using WordPerfect to prepare a draft report or using ForComment to provide editorial comments).

Data Analysis--using network provided software to perform data analysis (e.g., SAS, SPSS, etc.).

10. Please indicate how frequently (if at all) you used the LAN during fiscal year 1990 to perform each of the functions listed below. *(Check one for each.)*

FUNCTIONS	Never or Almost Never (1)	Once a Month or Less (2)	Several Times a Month (3)	Several Times a Week (4)	Daily (5)
1. Messaging					
2. File sharing					
3. File transfer					
4. Composition/editing					
5. Data analysis					

<u>Areas of responsibility</u>

Assignment Management--includes general management/oversight of individual or multiple assignments (e.g., preparing Form 100's, tracking assignment progress, preparing ratings, etc.).

Assignment Conduct--includes assignment/issue planning, data collection and analysis, report preparation and review, and product publishing and distribution.

GAO or Unit Management--includes obtaining, developing, and communicating information related to the tracking and scheduling of assignments and resources (i.e., staff and dollars) as well as training, travel, personnel information, scheduling, and other management information.

11. Please indicate how frequently (if at all) you used the LAN during fiscal year 1990 to meet each of the areas of responsibility listed below. *(Check one for each.)*

AREAS OF RESPONSIBILITY	Don't have this Responsi- bility (1)	Never or Almost Never (2)	Once a Month or Less (3)	Several Times a Month (4)	Several Times a Week (5)	Daily (6)
1. Assignment management						
2. Assignment conduct						
3. GAO or unit management						

12. Under PART A indicate whether the LAN had a positive, negative or no impact on the timeliness of the contributions you made during FY 1990 in each area listed below. *(Check one under PART A for each.)*

Under PART B indicate whether the LAN had a positive, negative or no impact on the quality of the contributions you made during FY 1990 in each area listed below. *(Check one under PART B for each.)*

PART A
Impact of LAN on Timeliness

PART B
Impact of LAN on Quality

AREAS OF RESPONSIBILITY	Nega- tive Impact (1)	No Impact (2)	Posi- tive Impact (3)	Didn't use LAN for this (4)	Nega- tive Impact (5)	No Impact (6)	Posi- tive Impact (7)	Didn't use LAN for this (8)
1. Assignment management								
2. Assignment conduct								
3. GAO or unit management								

13. In your opinion, has your use of the LAN in fiscal year 1990 had a positive, negative, or no impact on the following? Please exclude the use of hardware or software packages which another person performs as a service to you. *(Check one for each.)*

	Very Nega- tive Impact (1)	Some- what Nega- tive Impact (2)	No Impact (3)	Some- what Posi- tive Impact (4)	Very Posi- tive Impact (5)	No Basis to Judge (6)
1. Your personal productivity						
2. Quality of your products						
3. Calendar time to complete your jobs						
4. Number of staff days spent to complete your jobs						
5. Your capability to do new kinds of applications						
6. Your morale						
7. Your coordination with other GAO headquarters staff or management on data collection and analysis						
8. Your coordination with other GAO headquarters staff or management on developing report products						
9. Your communication/messaging with other GAO headquarters staff or management						
10. Your coordination with other GAO regional staff or management on data collection and analysis						
11. Your coordination with other GAO regional staff or management on developing report products						
12. Your communication/messaging with other GAO regional staff or management						
13. Sharing automated documents and files created by others working with you						

14. On average, during fiscal year 1990 how frequently (if at all) did you use each of the applications listed below in a LAN environment? *(Check one box for each.)*

APPLICATIONS	Never or Almost Never (1)	Once a Month or Less (2)	Several Times a Month (3)	Several Times a Week (4)	Daily (5)
1. Word processing (e.g., WordPerfect, etc.)					
2. Electronic spreadsheet (e.g., Lotus 1-2-3, etc.)					
3. Data base manager (e.g., Foxbase+, etc.)					
4. Communications (e.g., Email, etc.)					
5. Statistical analysis (e.g., SAS, etc.)					
6. Other *(Specify)* _____					

15. On average, during fiscal year 1990 how frequently (if at all) did you use each of the applications listed below in a stand alone environment? *(Check one box for each.)*

APPLICATIONS	Never or Almost Never (1)	Once a Month or Less (2)	Several Times a Month (3)	Several Times a Week (4)	Daily (5)
1. Word processing (e.g., WordPerfect, etc.)					
2. Electronic spreadsheet (e.g., Lotus 1-2-3, etc.)					
3. Data base manager (e.g., dBase, etc.)					
4. Communications (e.g., Xtalk, etc.)					
5. Statistical analysis (e.g., SAS, etc.)					
6. Other *(Specify)* _____					

16. Why do you use a microcomputer in the stand alone rather than the LAN environment? *(Check one.)*

    1. [   ] I rarely or never use a microcomputer in a stand alone environment

    2. [   ] The LAN is too difficult to learn

    3. [   ] It is difficult to find someone to help solve LAN problems

    4. [   ] It is easier to access software through the stand alone environment than through the LAN

    5. [   ] It takes less time to do the work in the stand alone environment

    6. [   ] The LAN does not have the software packages I need

    7. [   ] The operation of the LAN is too unreliable

    8. [   ] Other *(Specify.)* _____

17. Based on your experience, how adequate or inadequate is each of the following? *(Check one box for each.)*

	Much more than adequate (1)	More than adequate (2)	About adequate (3)	Less than adequate (4)	Much less than adequate (5)	No basis to judge (6)
1. Your access to a computer						
2. Your access to the LAN system						
3. The LAN printing capabilities						
4. The speed of the LAN						
5. The LAN training available to you						
6. The LAN technical support available to you						
7. The selection of software packages available through the LAN						
8. The operational reliability of the LAN						
9. Other *(Specify.)* _____						

PART IV—COMMENT

18. Please place any comments you may have concerning how computers are being used by you or others around you and how they have affected our work in the space below. Please indicate the other kinds of software packages you may be using in your GAO work which were not covered in this questionnaire. Also, please describe any changes you could make in your contributions to GAO using existing computer resources. Furthermore, please describe any changes you could make in your contributions to GAO if additional computer resources were made available.

Thank you for your assistance!